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MCAS EL TORO
SSIC # 5090.3

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, California 92132-5187

Contract No. N68711-92-D-4670

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CLEAN II

DRAFT FINAL
SOIL VAPOR EXTRACTION SYSTEM DESIGN WORK PLAN, SITE 24
MARINE CORPS AIR STATION EL TORO, CALIFORNIA

CTO-0142/0370
May 1998

Prepared by:

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401 West A Street, Suite 1000
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Signature: G. Patrick Brooks Date: 5/11/98

G. Patrick Brooks, R.G., CTO Leader

[redacted]

BECHTEL NATIONAL INC.

CLEAN II TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N-68711-92-D-4670 **Document Control No.:** CTO-0142/0370

File Code: 0214

TO: Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr. Richard Selby, Code 57CS1.RS
Building 127, Room 112
1220 Pacific Highway
San Diego, CA. 92132-5190

DATE: May 15, 1998
CTO #: 0142
LOCATION: MCAS El Toro

FROM: D. J. Tedaldi, Ph.D., P.E., Project Manager

DESCRIPTION: Replacement Page (Page 4-1) for Draft Final Soil Vapor Extraction System Design Work Plan Site 24 (VOC Source Area), DTD May 1998

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May 15, 1998

Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr. Richard Selby, Code 57CS1.RS
Building 127, Room 112
1220 Pacific Highway
San Diego, CA. 92132-5190

Attention: G. Steinway, Code 56MC.GS

Subject: Replacement Page (Page 4-1) for Draft Final Soil Vapor Extraction System Design Work Plan Site 24 (VOC Source Area), DTD May 1998

Dear Mr. Selby:

Attached please find Replacement Page 4-1 for the Draft Final Soil Vapor Extraction System Design Work Plan, Marine Corps Air Station (MCAS) El Toro, California, prepared under Contract Task Order (CTO) 0135 and Contract No. N68711-92-D-4670. The Draft Final Work Plan was issued on May 7, 1998. Page 4-1 of that plan should be removed and replaced with the attached Replacement Page.

Page 4-1 is being revised at the request of the RPM, Mr. Bernie Lindsey, to delete a sentence addressing BCT involvement. This sentence is being removed from Section 4.1 because BCT involvement in the remediation of the Site 24 vadose zone is already addressed in Section 1.3.2.

We apologize for any inconvenience that this replacement may have caused. If you have any questions or would like further information, please contact Pat Brooks at (619) 687-8851, or myself at (619) 687-8780.

Sincerely,

Dante J. Tedaldi, Ph.D., P.E.
Project Manager

DJT/sp

Enclosure: Replacement Page(Page 4-1) for Draft Final Soil Vapor Extraction System Design Work Plan Site 24 (VOC Source Area), DTD May 1998

BECHTEL NATIONAL INC.

CLEAN II TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N-68711-92-D-4670 Document Control No.: CTO-0142/0377

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Southwest Division
Mr. Richard Selby, Code 57CS1.RS
Building 127, Room 112
1220 Pacific Highway
San Diego, CA. 92132-5190

DATE: May 7, 1998
CTO #: 0142
LOCATION: MCAS El Toro

FROM: D. J. Tedaldi, Ph.D., P.E., Project Manager

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ACRONYMS/ABBREVIATIONS

AFB	Air Force Base
ARAR	applicable or relevant and appropriate requirement
BCT	BRAC Cleanup Team
bgs	below ground surface
BNI	Bechtel National, Inc.
BRAC	Base Realignment and Closure
Cal-EPA	California Environmental Protection Agency
CCR	*California Code of Regulations*
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	*Code of Federal Regulations*
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
DCE	dichloroethene
DON	Department of the Navy
DTSC	(Cal-EPA) Department of Toxic Substances Control
EDR	Engineering Design Report
EROI	effective radius of influence
FFA	Federal Facilities Agreement
FS	Feasibility Study
FSP	Field Sampling Plan
GAC	granular activated carbon
IWG	inches water gauge
JEG	Jacobs Engineering Group, Inc.
LDR	Land Disposal Restriction
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
O&M	operation and maintenance

ACRONYMS/ABBREVIATIONS (continued)

OHM	OHM Remediation Services Corp.
PCE	tetrachloroethene (perchloroethene)
QA	quality assurance
QC	quality control
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
RWQCB	(California) Regional Water Quality Control Board
SCAQMD	South Coast Air Quality Management District
scfm	standard cubic feet per minute
STLC	solubility threshold limit concentration
SVE	soil vapor extraction
SWDIV	Southwest Division Naval Facilities Engineering Command
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TTLC	total threshold limit concentration
U.S. EPA	United States Environmental Protection Agency
WET	waste extraction test
VOC	volatile organic compound

SECTION 1

INTRODUCTION

Section 1
INTRODUCTION

This Work Plan has been prepared by Bechtel National, Inc. (BNI) on behalf of the U.S. Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command (SWDIV) in accordance with Contract Task Order (CTO)-0142. This CTO was issued under the Comprehensive Long-Term Environmental Action Navy (CLEAN) II Program, contract No. N68711-92-D-4670. This Work Plan discusses the remedial action objectives, conceptual design, and design approach for a soil vapor extraction (SVE) system to address volatile organic compound (VOC)-contaminated soil at Marine Corps Air Station (MCAS) El Toro Site 24 (Figure 1-1). SVE was chosen as the preferred remedial alternative in the draft final Feasibility Study (FS) and the draft final Interim Record of Decision (ROD) for the Site 24 vadose zone (BNI 1997a,b).

1.1 PURPOSE AND SCOPE OF WORK PLAN

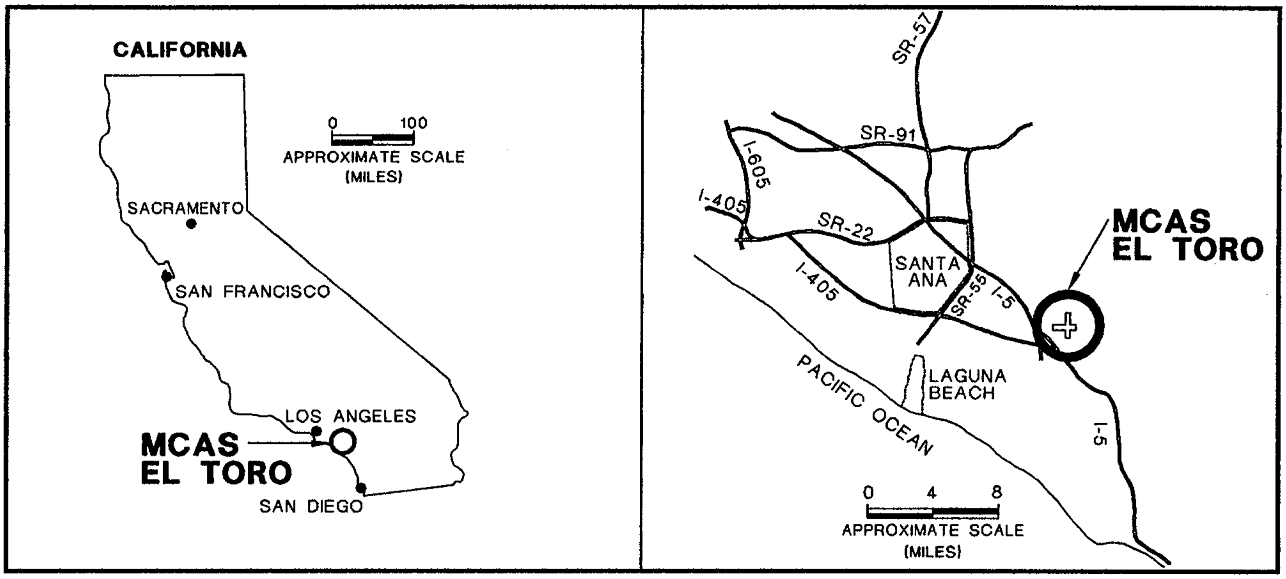
The purpose of this Work Plan is to establish the framework in which the proposed SVE system will be developed. The general approach to the development process is discussed and a preliminary outline for the detailed Engineering Design Report (EDR) is presented. This Work Plan and the ensuing engineering design are intended to address activities associated with SVE collection and treatment equipment as well as existing and proposed SVE wells at Site 24. Provisions have been made in this document and will be incorporated into the detailed design for build-out of a full-scale SVE system.

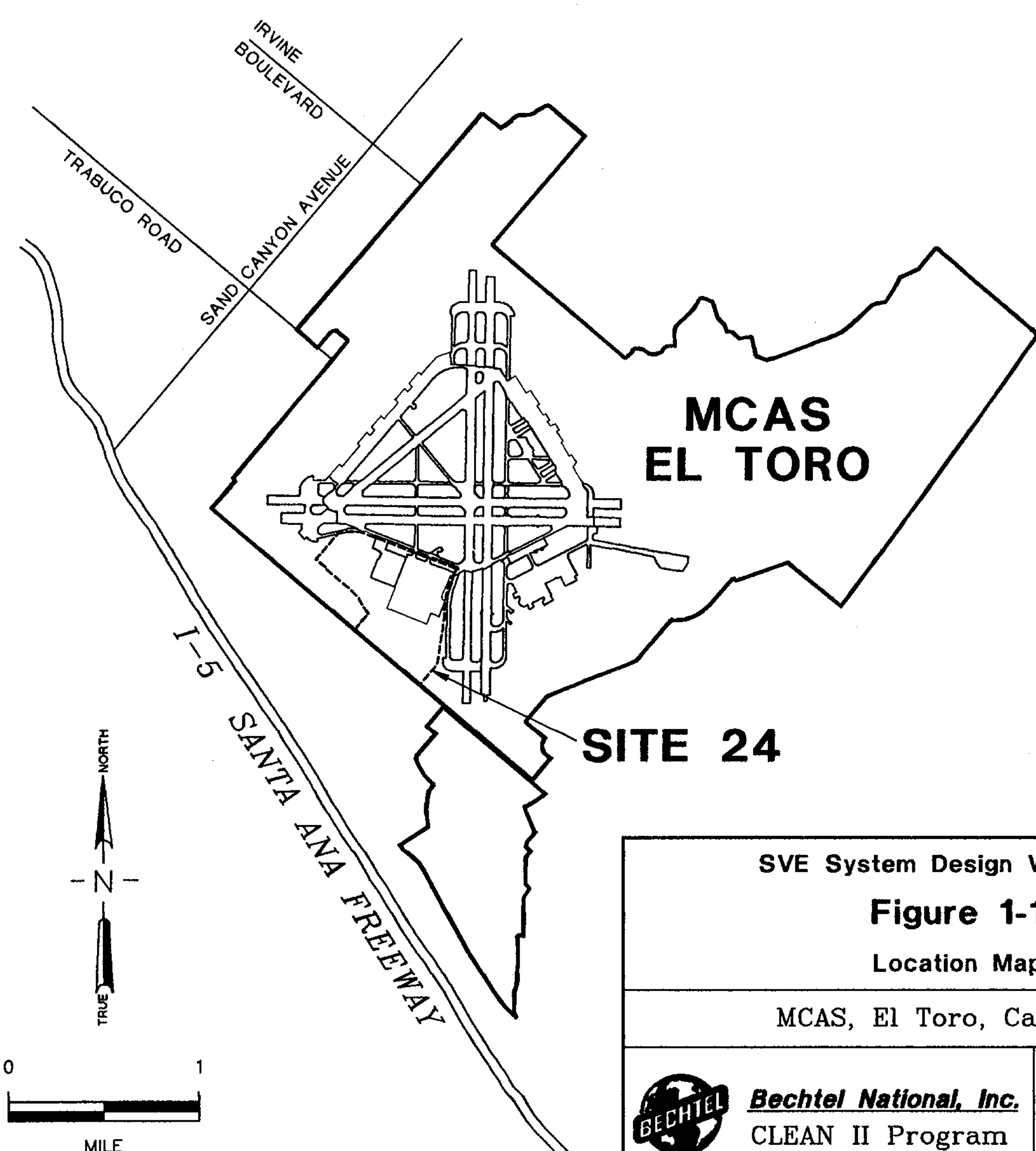
The DON and U.S. Air Force have coordinated to reuse the aboveground portion of the SVE system that was successfully used to remediate VOC-contaminated soil at Norton Air Force Base (AFB). These components include vacuum blowers, manifolds, heat exchangers, activated carbon vessels, and electrical supply networks. This Work Plan describes the Norton AFB SVE system and discusses how the system will be optimized with the SVE wells for remediation of soil at Site 24.

1.2 REMEDIAL ACTION OBJECTIVES

The project goals are summarized by the remedial action objectives (BNI 1997a). Based on site conditions and the anticipated exposure pathways, the following remedial action objectives were developed for soil at Site 24:

- reduce concentrations of VOCs in soil to prevent or minimize further degradation of the shallow groundwater unit; and
- continue vadose zone remediation until average VOC soil gas concentrations are below threshold concentrations (concentrations capable of contaminating groundwater above the maximum contaminant levels [MCLs]).





SVE System Design Work Plan

Figure 1-1

Location Map

MCAS, El Toro, California

Bechtel National, Inc. CLEAN II Program	Date: 4/23/98 File No: 142R2884 Job No: 22214-142 Rev No: B

1.3 GUIDANCE AND AGREEMENTS

General guidance for the project is provided in the Navy/Marine Corps Installation Restoration Manual (DON 1997), which defines how the DON will satisfy guidelines, regulations, and criteria associated with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act of 1986 (DON 1994); the Marine Corps Environmental Compliance and Protection Manual (DON 1990); and the United States Environmental Protection Agency (U.S. EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA 1988). This work will be conducted under the general guidance of the October 1990 Federal Facilities Agreement (FFA) among the DON; U.S. EPA Region IX; and California Department of Health Services (now referred to as the California Environmental Protection Agency [Cal-EPA]), represented by the Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB) Santa Ana Region. The FFA is a cooperative agreement among the DON, U.S. EPA, and Cal-EPA (DTSC and RWQCB Santa Ana Region) that:

- assures that environmental impacts are investigated and appropriate response actions are taken to protect public health and the environment;
- establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions;
- facilitates cooperation, exchange of information, and participation of the parties; and
- assures adequate assessment, prompt notification, cooperation, and coordination between federal and state agencies.

The implementation of the FFA is included as one of the responsibilities of the Base Realignment and Closure (BRAC) Cleanup Team (BCT). The BCT consists of representatives from SWDIV, U.S. EPA, and Cal-EPA (DTSC and RWQCB Santa Ana Region). It was established to manage and coordinate environmental restoration and compliance programs related to closure and disposal of MCAS El Toro by July 1999. In addition, the MCAS El Toro BCT has specified in its mission and vision statements that:

- fast-track remediation of sites is necessary to expedite reuse; and
- restoration and reuse is to be maximized by 1999.

1.3.1 Specific Guidance

Recent U.S. EPA guidance (U.S. EPA 1996) advocates the use of a phased-response approach for site characterization and response activities. In the phased-response approach, response actions are implemented in a sequence of steps or phases such that information gained from earlier phases is used to refine subsequent actions. A similar approach has been adopted for actions at Site 24. The SVE pilot testing is envisioned as the first phase. During this phase, some of the existing SVE wells have been tested to establish the long-term effectiveness of SVE. Through operational data collection and evaluation, expansion of the SVE system (by adding additional SVE wells and Norton AFB equipment) will be assessed. The engineering design activities described in this Work Plan include provisions for preliminary design of expansion facilities; however, these facilities will be installed only if there is an indicated need.

Specific guidance for remedial design is found in the U.S. EPA document Remedial Design/Remedial Action Handbook (U.S. EPA 1995). The handbook provides principles to effectively implement a selected remedy in accordance with the Record of Decision. Additional specific U.S. EPA guidance is referenced in the handbook, as appropriate.

1.3.2 BCT Involvement

This project will be performed with a high degree of communication and interaction with the BCT. BCT interaction will be especially important during SVE well installation and testing (Section 4.1). The BCT has decided to reuse the aboveground portion of the SVE system currently at Norton AFB to the extent that it is feasible. CLEAN II has performed a preliminary evaluation of the Norton AFB system and concluded that the system appears to have sufficient flexibility for use at Site 24. The aboveground portion of the system design and operation has been previously reviewed and approved by the U.S. EPA, DTSC, and RWQCB Santa Ana Region. It is expected that the aboveground portion will be relocated to MCAS El Toro and used in essentially the same manner as at Norton AFB. The belowground portion of the Site 24 SVE system will be site specific.

1.4 SITE HISTORY

MCAS El Toro was commissioned in 1943 as a Marine Corps pilot fleet operation training facility. In 1950, the Station was selected for development as a master jet station and permanent center for Marine Corps aviation on the West Coast. The Station mission has involved the operation and maintenance of military aircraft and ground-support equipment. Much of the industrial activity supporting this mission took place in the southwestern quadrant of the Station, where Site 24 is located.

Past operations and practices at MCAS El Toro have contributed to VOC contamination in soil and groundwater. Industrial activities at Site 24 (e.g., dust suppression with waste liquids, paint stripping, degreasing, vehicle and aircraft washing, and waste-disposal practices) may have involved the use of solvents containing VOCs (e.g., trichloroethene [TCE] and tetrachloroethene [PCE]). Wastes from these practices may have reached the surface or subsurface through leakage, runoff, storm drains, or direct application to the soil. These wastes may be the source of VOCs detected in the regional groundwater. However, an extensive records review found no documentation of TCE usage.

The first indication of contamination at the Station occurred during routine water quality monitoring in 1985, when the Orange County Water District discovered TCE in groundwater at an irrigation well located approximately 3,000 feet downgradient of

MCAS El Toro. As a result of Orange County Water District groundwater investigations, the U.S. EPA placed the Station on the Superfund National Priorities List in February 1990.

1.5 SITE CHARACTERIZATION ACTIVITIES

A significant amount of data have been collected and interpreted to characterize the regional VOC groundwater contamination and potential source areas. The principal investigations, in terms of characterizing the nature and extent of VOC contamination, are the Phase I Remedial Investigation (RI) (JEG 1993, 1994a), the Phase I Soil Gas Survey (JEG 1994b), and the Phase II RI (BNI 1996).

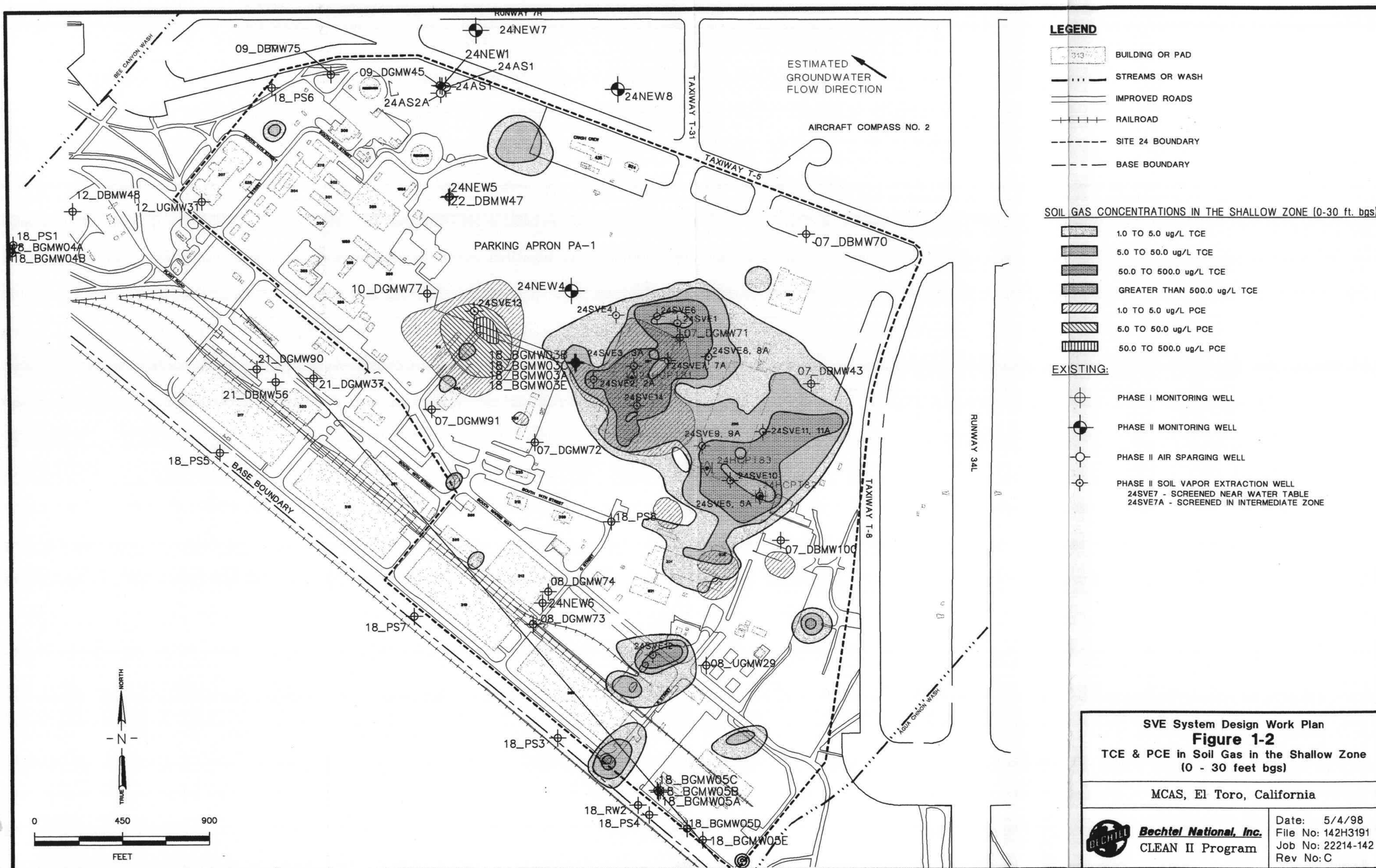
The Phase I RI groundwater characterization revealed a plume of TCE in groundwater originating beneath Site 24 and extending approximately 3 miles off-site and downgradient of MCAS El Toro. The area of highest TCE concentration in groundwater was identified beneath Site 24, approximately 1,500 feet northwest of Building 297.

The Phase I soil gas survey identified potential VOC sources at Site 24 by collecting soil gas samples from the upper 30 feet of soil. TCE in soil gas was detected throughout a large area beneath Buildings 296 and 297, but the area of highest TCE concentrations in groundwater was separated from this apparent vadose zone source by approximately 1,500 feet.

The Phase II RI extended the characterization of VOCs in the vadose zone to the water table. A primary TCE source in the vadose zone was found in the soil beneath Buildings 296 and 297. This source extends south with decreasing concentrations to the southern Station boundary. Groundwater samples collected from beneath Buildings 296 and 297 effectively linked the vadose zone source to the regional VOC groundwater contamination. The Phase II RI showed that the highest concentrations of TCE in the groundwater were beneath Building 296. Figures 1-2 through 1-4 show the distribution of TCE and PCE in the vadose zone soil gas based on discrete soil gas sampling data collected in 1995. Where long-term pilot tests have been conducted (24SVE1, 24SVE3, 24SVE9, and 24SVE10), a reduction in VOC concentrations has occurred, although it is not shown on these figures.

1.6 NATURE AND EXTENT OF VADOSE ZONE CONTAMINATION

The Phase I RI sampling and analysis program demonstrated that soil gas sampling was the most effective way to characterize the nature and extent of VOCs in the vadose zone. Potential source areas were identified by investigating the upper 20 feet of soil, with some samples collected as deep as 30 feet below ground surface (bgs). Elevated concentrations of TCE were identified beneath Buildings 296 and 297. The Phase II investigation extended the Phase I soil gas survey by sampling for VOCs from approximately 30 feet bgs to the groundwater. Together, these soil gas investigations characterized the horizontal and vertical extent of VOCs in the vadose zone.



SVE System Design Work Plan

Figure 1-2

TCE & PCE in Soil Gas in the Shallow Zone (0 - 30 feet bgs)

MCAS, El Toro, California

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CLEAN II Program

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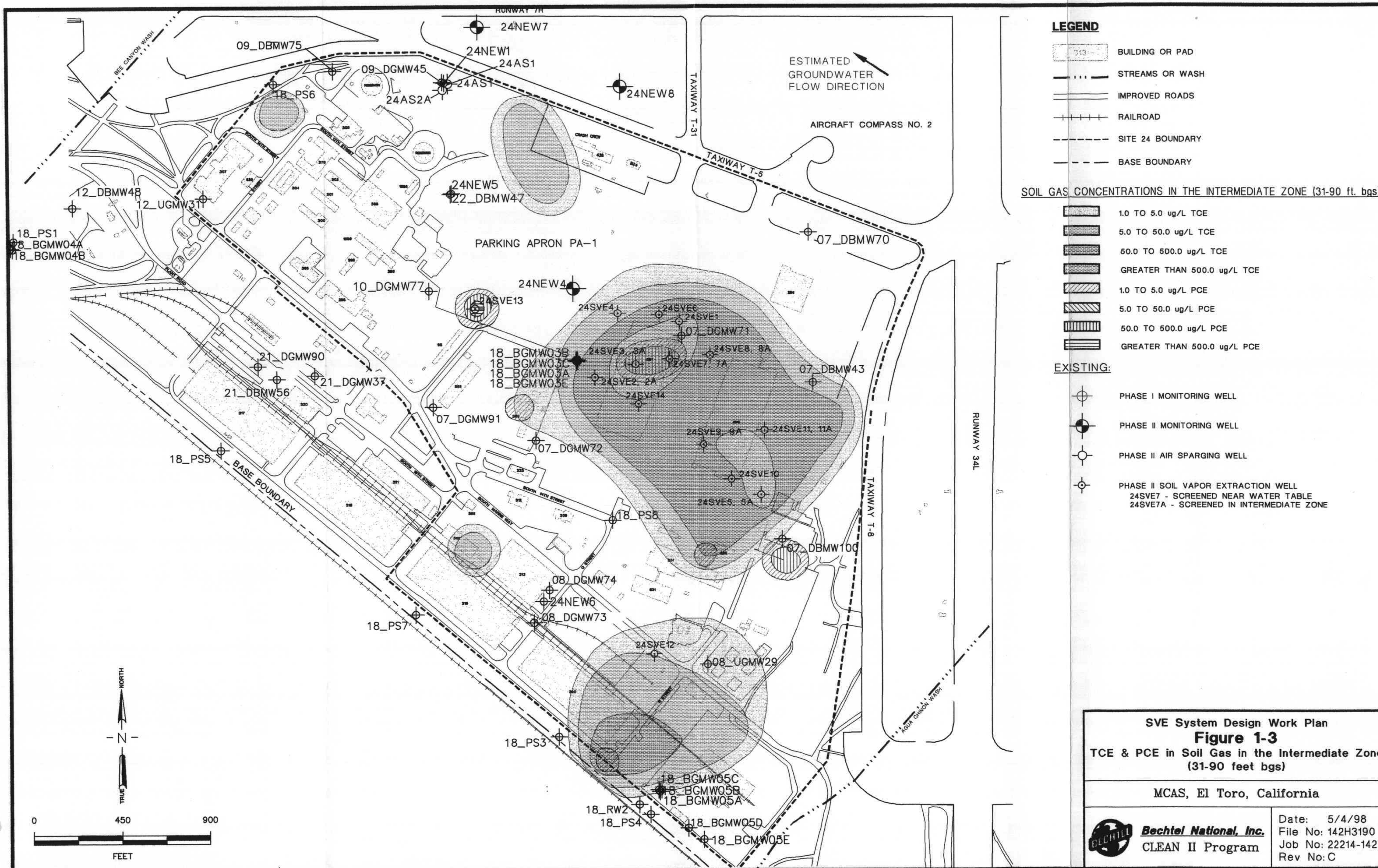

SVE System Design Work Plan

Figure 1-3

TCE & PCE in Soil Gas in the Intermediate Zone (31-90 feet bgs)

MCAS, El Toro, California

Bechtel National, Inc.
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Date: 5/4/98
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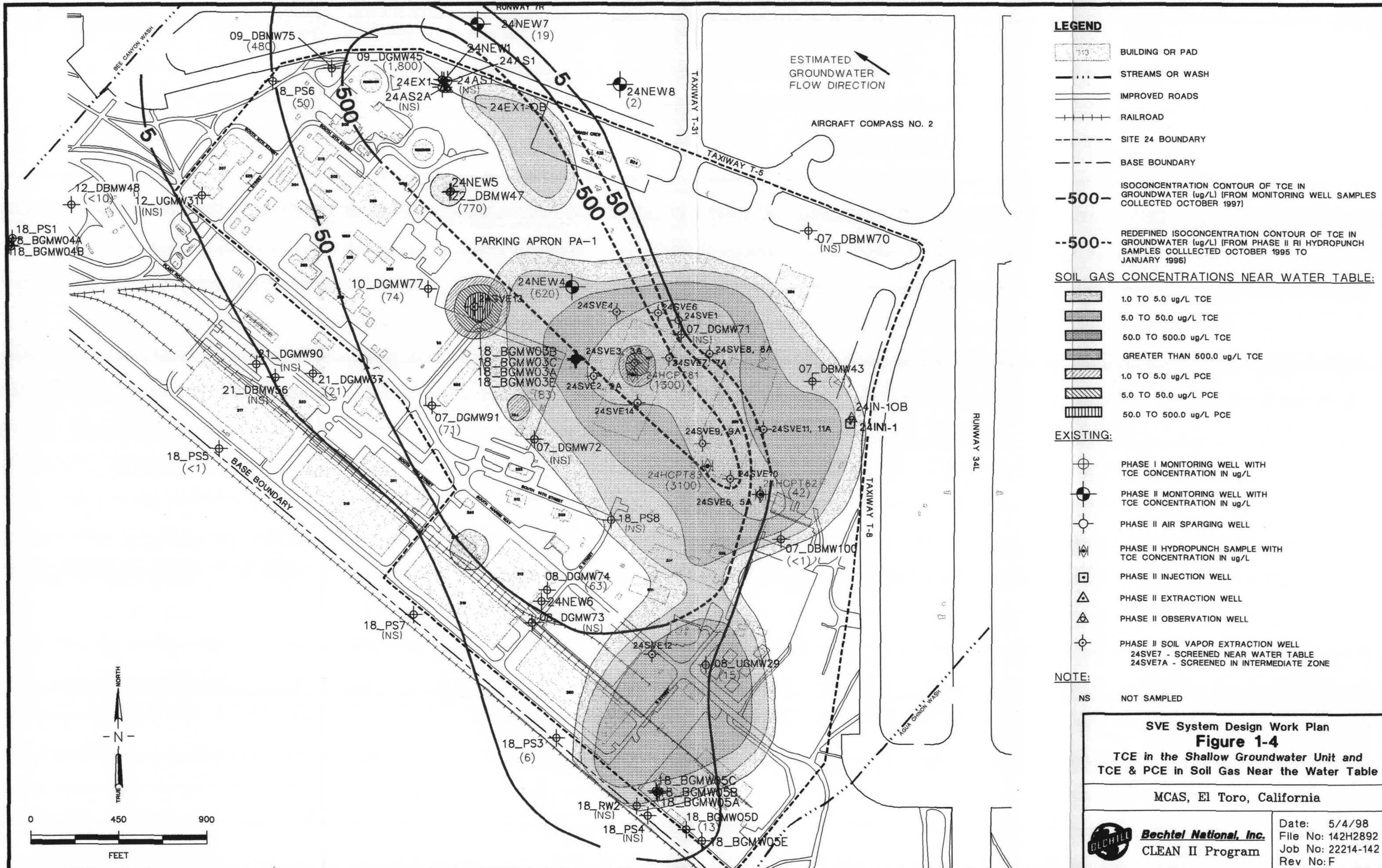

SVE System Design Work Plan

Figure 1-4

TCE in the Shallow Groundwater Unit and TCE & PCE in Soil Gas Near the Water Table

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 5/4/98
File No: 142H2892
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Rev No: F

TCE concentrations in soil gas generally increase with depth, with the highest concentrations found near the water table. VOCs in the area of Buildings 296 and 297 extend to groundwater directly beneath those buildings. Measured soil gas and groundwater TCE concentrations demonstrate that TCE mass flux is from the vadose zone toward groundwater. The trend of increasing soil gas concentrations with depth suggests a depleting source at the surface that is consistent with the assumed end of TCE usage around 1975. The TCE-contaminated area also extends south of Buildings 296 and 297, decreasing in concentration toward the southern Station boundary.

In general, TCE concentrations in soil gas increase and are more widely distributed with depth. The highest concentrations are near the water table. TCE in soil gas was reported at concentrations up to 6,120 micrograms per liter (µg/L), which exceeds the concentration in equilibrium with TCE-contaminated groundwater. This indicates that an active mechanism exists to transfer TCE from the vadose zone to groundwater. Lower TCE concentrations in soil and soil gas near the surface may be due to continued flushing by infiltrating water after TCE use was discontinued and by volatilization of the TCE into the atmosphere.

In general, VOCs were reported in soil samples only at very low concentrations. This is probably due to a low organic carbon content in the soil and release of TCE to the vadose zone in the dissolved phase. Although much of the VOC contamination present at Site 24 is believed to have entered the soil at or close to the surface, the amount of contamination currently near the ground surface is small relative to that found deeper in the vadose zone. Soil samples collected from the upper 10 feet of soil at Site 24 contained VOC concentrations less than 21 micrograms per kilogram (µg/kg). The highest TCE concentration reported in the vadose zone during the Phase I RI was 400 µg/kg; during the Phase II RI, the highest reported TCE concentration was 190 µg/kg.

1.7 SITE 24 VADOSE ZONE RECORD OF DECISION CONCLUSIONS

The draft final vadose zone ROD confirmed that SVE is the selected remedial alternative for removing VOCs from the vadose zone at Site 24. Performing soil cleanup using SVE at Site 24 would eliminate most of the TCE and other VOCs that serve as a source of the regional groundwater contamination. With most of the soil contamination eliminated, time required for follow-up groundwater cleanup would be reduced. Soil and groundwater cleanup will be conducted independently. This strategy coincides with the goal of conducting expedited efforts to clean up the Station in support of eventual closure and reuse of the property.

In summary, the selected remedial alternative includes the following:

- construction, operation, and maintenance of an SVE system using a phased approach to remediation;
- performance monitoring to be conducted throughout the predicted 2 to 4 years of remediation;

- treatment of VOC-contaminated soil gas (vapors) with activated-carbon filters to meet discharge standards prior to discharge into the atmosphere;
- confirmatory soil gas sampling at the end of the vadose zone remediation to confirm that average VOC concentrations are too low to contaminate groundwater above the MCLs; and
- resampling of the vadose zone at the conclusion of groundwater remediation; if the average soil gas concentrations are found to be above the threshold limits, additional vadose zone remediation may be necessary.

SVE addresses the primary risk posed by soil contamination (which can be characterized as a principal threat at this site) by removing and permanently destroying the contaminants from soils, thereby significantly reducing the toxicity, mobility, or volume of hazardous substances. By removing VOCs from the soil, further groundwater contamination is minimized or prevented, thereby reducing the time required for groundwater remediation.

1.8 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Soil vapor extraction and aboveground vapor treatment will be performed in compliance with all applicable federal, state, and local regulations, including South Coast Air Quality Management District (SCAQMD) regulations. Applicable or relevant and appropriate requirements (ARARs) were evaluated in the draft final FS (BNI 1997a) and finalized in the interim ROD (BNI 1997b). Chemical-specific, location-specific, and action-specific ARARs for the Site 24 remedial actions are listed below.

Chemical-Specific ARARs:

Generator Requirements	Title 22, *California Code of Regulations* (CCR), Division 4.5, Section 66261.24(a), 66261.22(a)(3) and (4), 66261.24(a)(2) to (a)(8), 66261.101, 66261.3(a)(2)(C), or 66261.3(a)(2)(F)
Discharge to Groundwater	22 CCR 66264.94, except 66264.94(a)(2), and 94(b)

Location-Specific ARARs:

Floodplain Protection	22 CCR 66264.18(b); 40 *Code of Federal Regulations* (CFR) Section 6, Appendix A, excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302

Action-Specific ARARs:

Hazardous Waste Determination	22 CCR Division 4.5, Section 66262.10(a) and 66262.11

Pretransport Requirements	22 CCR 66262.30 through 66262.33
Generator Standards	22 CCR 66262.34
Clean Air Act	40, *United States Code*, Section 7410; portions of 40, CFR, Section 52.220
SCAQMD Rules	Rule 1303 – New Source Review Rule 1401 – New Source Review of Toxic Air Contaminants

1.9 DISCHARGE TREATMENT STANDARDS

Primary discharges from the SVE pilot system will include air emissions and VOC-contaminated condensate. These discharges will be controlled by ARARs and the use of technologies that meet all discharge requirements and are judged to be the best practicable treatment, best demonstrated available technology, and best available control technology for addressing TCE (and other VOCs) in soil.

SCAQMD Rules 1303 and 1401 were identified as applicable. Rule 1303 requires that best available control technology be applied to any source that may result in a net increase of halogenated hydrocarbons or nonattainment of air contaminant levels. Rule 1401 requires that best available control technologies for toxics be applied to equipment emitting chemicals at concentrations exceeding the maximum allowable individual cancer risk. Numeric discharge standards have not been established for SVE air emissions.

Remedial actions taken under CERCLA §§ 104, 106, or 122 that are conducted entirely on-site do not require federal, state, or local permits. However, DON will prepare a Permit Equivalency Package demonstrating compliance with the substantive requirements of SCAQMD Rules 1303 and 1401. This package will include a human-health risk assessment based on the expected emissions generated by the SVE system. The Permit Equivalency Package will be included in the EDR and will be reviewed by the BCT.

ARARs for discharges of condensate from the SVE system were not specifically addressed in the FS. Condensate will be discharged to the MCAS El Toro Central Treatment Facility located at Site 3 or at a groundwater treatment system planned for the site. These discharges to the Central Treatment Facility or the groundwater treatment system will not require any pretreatment.

1.10 WASTE CLASSIFICATION AND DISPOSAL

Wastes, such as drill cuttings, spent activated carbon, water condensate, and contaminated personal protective equipment, will be generated during the on-site activities associated with constructing and operating the SVE system at Site 24. With the possible exception of spent activated carbon, these wastes are not expected to be classified as characteristic hazardous wastes. The following subsections describe the criteria that will be used to determine whether a waste is hazardous and present disposal options for both hazardous and nonhazardous waste.

Federal and state regulations will govern the management of waste at Site 24. These criteria are described in the final Investigation-Derived Waste Management Plan for MCAS El Toro (BNI 1995) and are summarized in the following subsections.

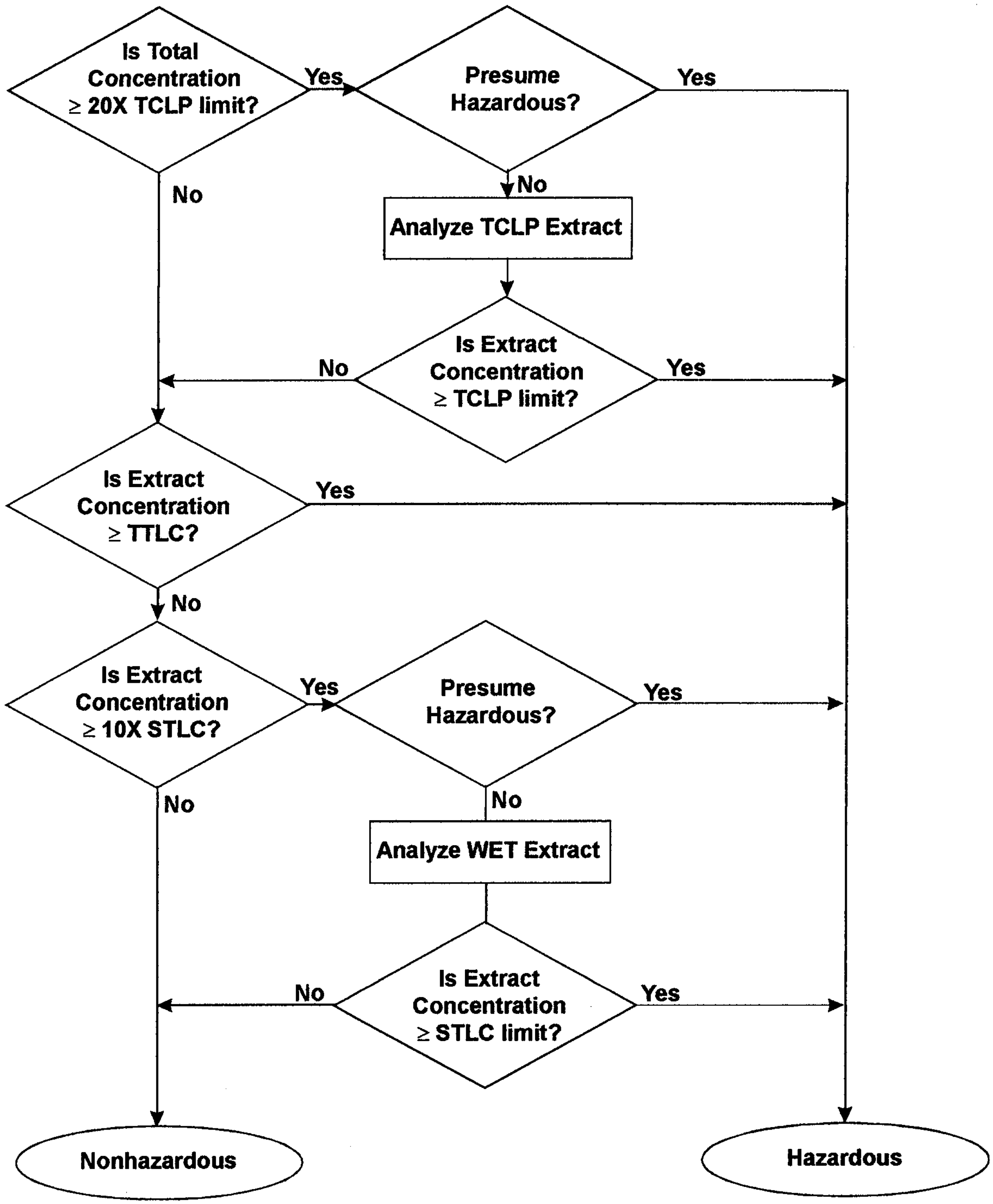
1.10.1 Federal Hazardous Waste Criteria

Federal waste classifications are defined in 40 CFR 261. After a waste has met the definition of a solid waste (40 CFR 261.2 and 40 CFR 261.4a) and is determined not to be an excluded waste (40 CFR 261.4b), it will become a hazardous waste if it is a listed waste (40 CFR 261.31 to 261.33). If the waste is not a listed waste, it still may be considered a hazardous waste due to its hazardous characteristics (40 CFR 261.21 to 261.24), which include ignitability, corrosivity, reactivity, and toxicity. The procedures specified in 40 CFR 262.11 will be followed to determine whether the waste is hazardous or nonhazardous.

Listed waste definitions are process- and industry-specific or related to off-specification and discarded chemicals. Definitions of listed waste and characteristics of ignitability, corrosivity, and reactivity are not likely to apply to the waste generated during the SVE system installation and operation activities as determined from previous sampling results. Toxicity will be the principal parameter to classify hazardous waste for the waste generated during remedial activities at Site 24.

The toxicity characteristic of a waste can be tested using the toxicity characteristic leaching procedure (TCLP) test (40 CFR part 261). The TCLP is an extraction test (for soil or for liquids containing greater than 0.5 percent solids by weight) designed to determine the mobility of the more common organic and inorganic contaminants present in a waste. Total analyte concentrations in liquids containing less than 0.5 percent solids by weight (as is expected for liquid waste generated at the site) are compared directly with the TCLP regulatory standards. Although the regulatory threshold standards apply strictly to contaminant concentrations in the TCLP extract, total contaminant concentrations, as measured by the methods used for sample analysis, can be compared to the TCLP standards and be used as a guideline to determine whether the waste associated with the sample warrants TCLP testing.

For solids, if the total concentration of an analyte is less than 20 times the TCLP regulatory standard for that compound, it can be assumed that the waste is not hazardous under the analyte toxicity criteria. However, if the total concentration of the analyte is more than 20 times the respective TCLP regulatory standard, the sample must undergo the TCLP test to determine whether or not the sample is hazardous under the toxicity criteria for that analyte. The hazardous waste determination procedure is depicted in Figure 1-5.



SVE System Design Work Plan

Figure 1-5

Federal and California Hazardous Waste Determination (Toxicity)

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 4/27/98
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1.10.2 California Hazardous Waste Criteria

In California, 22 CCR has been recodified in order to obtain Resource Conservation and Recovery Act authorization. The recodification uses the text and format of 40 CFR 260 to 270 as a basis, but it incorporates more stringent and broader jurisdictional amendments where applicable (22 CCR Section 66261.1 et. seq.).

California hazardous waste criteria include the federally listed wastes and hazardous characteristics criteria (e.g., toxicity, ignitability, reactivity, and corrosivity) described above. In addition to the TCLP criteria for toxicity, the California regulations include an additional set of standards for determining toxicity. Threshold standards, both total threshold limit concentration (TTLC) and solublility threshold limit concentration (STLC), are promulgated for 20 metals and 18 organics, mostly herbicides and pesticides.

Total contaminant concentrations are compared to the TTLC values and the results of the California waste extraction test (WET) (similar to the TCLP test) are compared to the STLC values. Similar to federal requirements, total contaminant concentrations can be used as guidelines to determine whether the WET procedure is needed. However, a factor of 10 is used to compare total contaminant concentrations to STLC values due to a difference in dilution factors between the TCLP and STLC tests. The process of this comparison is illustrated in Figure 1-5.

1.10.3 Waste Disposal

Following classification, the waste will be handled and disposed according to its classification, as described below. Additional sampling and analysis may be required for toxic substances disposal facility acceptance at both hazardous and nonhazardous waste facilities. A Uniform Hazardous Waste Manifest shall be prepared for every hazardous waste shipment going off-Station to an authorized disposal facility. The manifest shall be signed by an authorized representative of the MCAS El Toro Base Environmental Coordinator.

California regulations relate waste classifications with classes of waste management units. Designated wastes must be disposed in Class II or higher facilities. Nonhazardous solid wastes must be disposed in Class III or higher facilities.

Federal and state land-disposal restrictions (LDRs) are in effect for most hazardous wastes. Based on the results of hazardous waste testing, LDRs will be identified for all contaminants that are considered hazardous. Although hazardous contaminants are not known at this time, LDRs for potentially hazardous contaminants will be identified in the EDR.

Nondesignated, nonhazardous solid waste shall either be transported to a Class II or Class III facility permitted to accept the material or be used as cover material for one of the landfill sites at MCAS El Toro. In some cases, nonhazardous soils may be spread on the ground at the site of generation. This will be done only with regulatory and DON approval. Nonhazardous wastewater shall be disposed through the granular activated carbon (GAC) system at the MCAS El Toro Central Treatment Facility or through the base sanitary sewer system (after receiving authorization from DON).

1.11 INSTITUTIONAL CONTROLS

Institutional controls, including deed restrictions and access restrictions, are not required at this time to protect human health because surface and near-surface soils have low levels of VOC contamination and present a very low incremental risk to human health. However, deed restrictions will be necessary to protect the integrity of the remedy. These deed restrictions will serve two purposes: first, deed restrictions will be used to allow DON and regulatory agencies access to SVE wells, monitoring wells, and piping in order to operate the system and monitor the progress of remediation; second, deed restrictions will be used during remediation to prevent disturbance of SVE wells, monitoring wells, piping, and SVE equipment. DON has the responsibility for implementing these controls. Transfer of the property will be in accordance with Section 120(h)(3) of CERCLA.

1.12 OTHER DOCUMENTATION

In addition to this Work Plan, the following documents will be prepared to support the use of SVE for remediation at Site 24.

- An EDR will be developed. The EDR will provide SVE design criteria, design details, a compatibility evaluation of the Norton AFB SVE system, implementation details, site restoration plans, and reporting requirements. A preliminary outline of the EDR is presented in Appendix A.
- A Contingency Plan will be developed. The Contingency Plan will include an emergency response plan (including a spill control plan) and a description of contingencies that may be implemented if the SVE system does not accomplish the cleanup goals.
- A Quality Assurance (QA)/Quality Control (QC) Plan will be developed. This plan will be used during system installation and will include drilling and testing methods, well spacing decision trees, and instructions for QA/QC of piping and equipment installation.
- An Operations and Maintenance (O&M) Plan was developed by EARTH TECH for use at Norton AFB (EARTH TECH 1996). This plan contains the following information:
  - description of start-up procedures;
  - description of normal O&M procedures at design operating conditions;
  - a troubleshooting guide;
  - emergency shutdown procedures; and
  - description of record keeping and testing requirements.

The Norton AFB O&M Plan will be reviewed and a similar plan will be prepared for use at Site 24.

- A site-specific Safety and Health Plan will be developed. This plan will address how federal, state, and local requirements regarding human health and safety will be implemented during construction, operations, and maintenance of the SVE system. This plan will be provided by DON after final remedial design and prior to remedial action.
- A Field Sampling Plan (FSP) will provide an overview of field sampling procedures and data-gathering methods that will be used during SVE system installation. The FSP will be augmented by the O&M Manual once SVE system operation begins.
- A Site Management Plan will be developed. The Site Management Plan will describe how access issues, security, and interfaces between the various contractors implementing the remedial action are to be handled. This plan will be provided by DON after final remedial design and prior to remedial action.
- A Quality Assurance Project Plan will be prepared to describe procedures that will be used to assure that data collected during SVE installation are precise, accurate, representative, complete, and comparable to actual site conditions and that technical project procedures are followed during collection, sample analysis, and data evaluation.

SECTION 2

SVE PILOT TEST SUMMARY

Section 2
SVE PILOT TEST SUMMARY

As part of the phased-response approach to remediation, SVE pilot tests were conducted from June 1996 to September 1997 to evaluate the feasibility of using SVE to remove VOCs from the contaminated soil. The pilot tests were an integrated team effort that combined the resources and expertise from the CLEAN II contractor and the Remedial Action Contract contractor (OHM Remediation Services Corporation [OHM]) under the oversight of SWDIV. The SVE pilot test objectives included the following:

- evaluating the feasibility of using SVE to remove VOCs from contaminated soil beneath Site 24;
- evaluating SVE radius of influence (ROI);
- estimating the mass of VOCs removed from the contaminated soil during SVE pilot testing;
- estimating the VOC removal versus time and overall effectiveness of SVE at the test site; and
- establishing operating parameters to optimize SVE performance.

2.1 SVE PILOT TEST CONCLUSIONS

Twenty one-day SVE pilot tests were conducted at individual SVE wells installed during the Phase II RI. Four of these wells were selected for longer-duration pilot tests. The pilot test data confirm that SVE is a feasible technology to remove VOCs from unsaturated soil at Site 24. Specific conclusions are presented below.

- The spatial distribution and concentrations of VOCs reported in SVE well samples are consistent with the results of the Phase II RI. TCE was reported in samples from every SVE well. Other VOCs with localized occurrences include Freon 113, 1,1-dichloroethene (DCE), and PCE.
- Soil permeability estimates were made for seven SVE wells. Soil permeability to airflow ranged from 1.7×10^{-7} to 7.8×10^{-9} square centimeters. These values correspond to fine and medium sands (Johnson et al. 1990a).
- The ROI estimates from seven SVE wells ranged from 50 to 460 feet. ROI is defined as the radial distance at which the soil gas pressure in the vadose zone is equal to one percent of the applied pressure at the SVE well.
- Travel time for a soil gas particle to reach the SVE well was estimated as a function of radial distance from the well. Other factors that influence travel time are permeability, applied pressure, and air-filled porosity. Travel time estimates can be used to calculate critical velocity and the amount of time necessary to draw one pore volume of air through the contaminated soil. This type of information will be used during remedial design to help locate new SVE wells and estimate remediation time.
- The combined mass of TCE removed during pilot testing was 821 pounds, representing 57 percent of the total VOC mass removed. Freon 113 represented

37.5 percent (540 pounds) of the total mass removed. 1,1-DCE represented 5.4 percent (78.2 pounds) of the total mass removed, and PCE represented 0.1 percent (2 pounds) of the total mass removed.

- A total of 1,441 pounds of VOCs were removed from Site 24 as a result of the SVE pilot tests (Figure 2-1).
- Airflow measurements are critical pieces of data used to calculate soil permeability and soil gas travel time. Airflow readings collected with the hot-wire anemometer were not as consistent as those made with a rotameter.

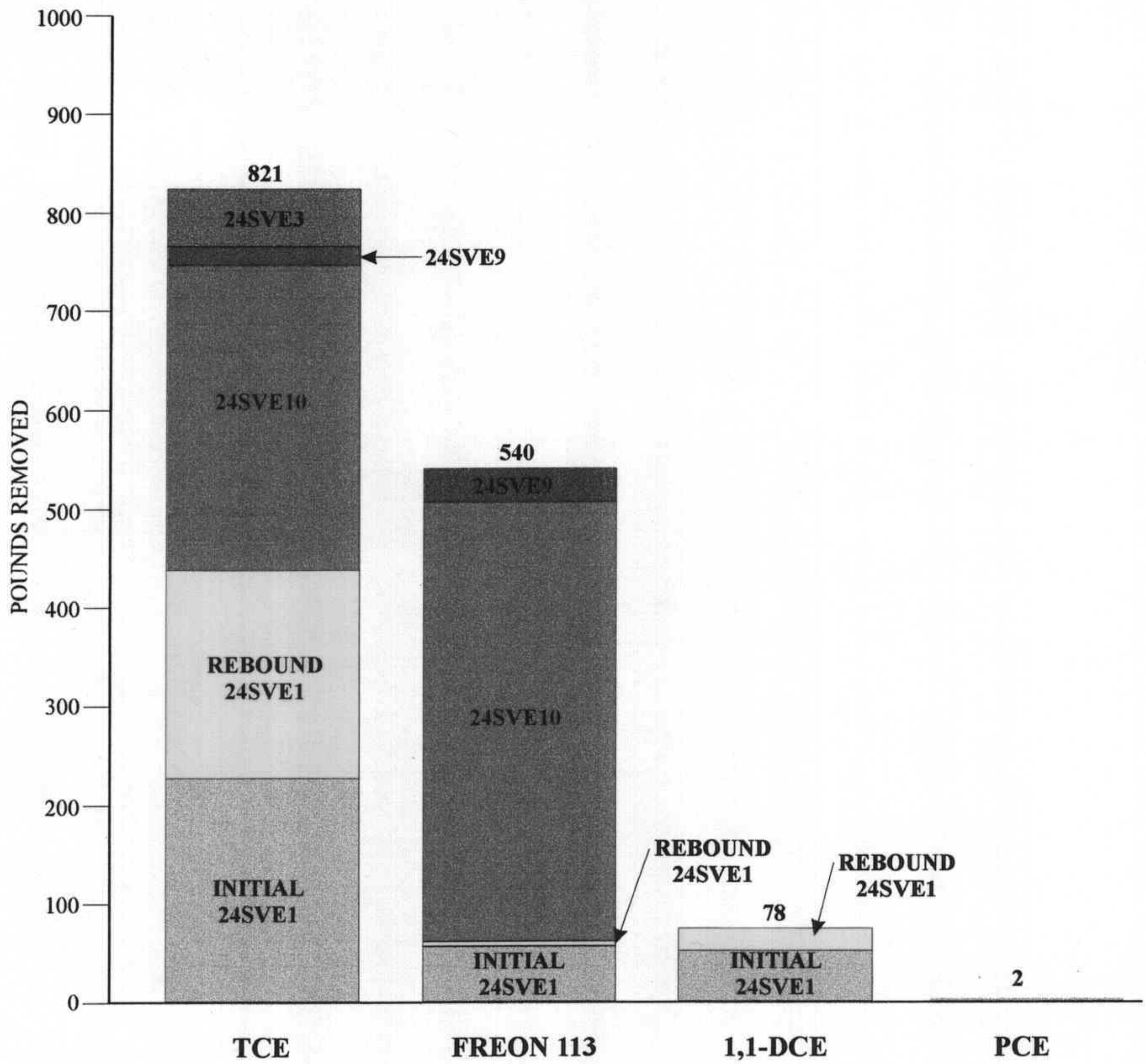
2.2 SVE PILOT TEST RECOMMENDATIONS

Specific recommendations resulting from the SVE pilot tests are the following:

- Continue the SVE pilot test program, and collect additional data to assist in the design of the SVE well field.
- Begin the SVE well field installation in the area of highest TCE concentrations in soil gas, based on the results of pilot testing. Criteria to be considered include soil permeability, soil gas travel time, and site stratigraphy. Additional wells are needed to characterize permeability to airflow, radius of influence, and soil gas travel time. The SVE wells that did not yield ROI estimates will be retested as additional wells are added that can serve as monitoring points.
- During the pilot tests, SVE airflow should be measured using a rotameter to provide more reliable and consistent flow measurements. Discontinue the use of the hot-wire anemometer when the data are used to calculate permeability and soil gas travel time.
- Remote pressure measurements should be made using a sealed slip cap and valve arrangement on the monitoring well. This allows the pressure inside the well to remain nearly constant during measurement, and it permits small variations in pressure to be measured quickly.

2.3 FOLLOW-ON PILOT TESTING

Follow-on pilot testing was conducted in March 1998 at ten SVE wells using rotameter-type flow meters. Flow versus vacuum curves were plotted using the new data (Figure 2-2). The SVE airflow data appeared to characterize three permeability zones that are stratigraphically controlled. The permeability zones were used to further refine the ROIs and identify a conceptual layout for the SVE well field. The conceptual layout is discussed in Section 3.3 of this report.



NOTES: Mass removals less than 5 pounds per well are not shown.
cfm - cubic feet per minute.

Well	Flow rates (cfm)	Test duration (days)
24SVE1 (initial)	200	19
24SVE1 (rebound)	185	84
24SVE3	76	65
24SVE9	14	62
24SVE10	190	44

SVE System Design Work Plan

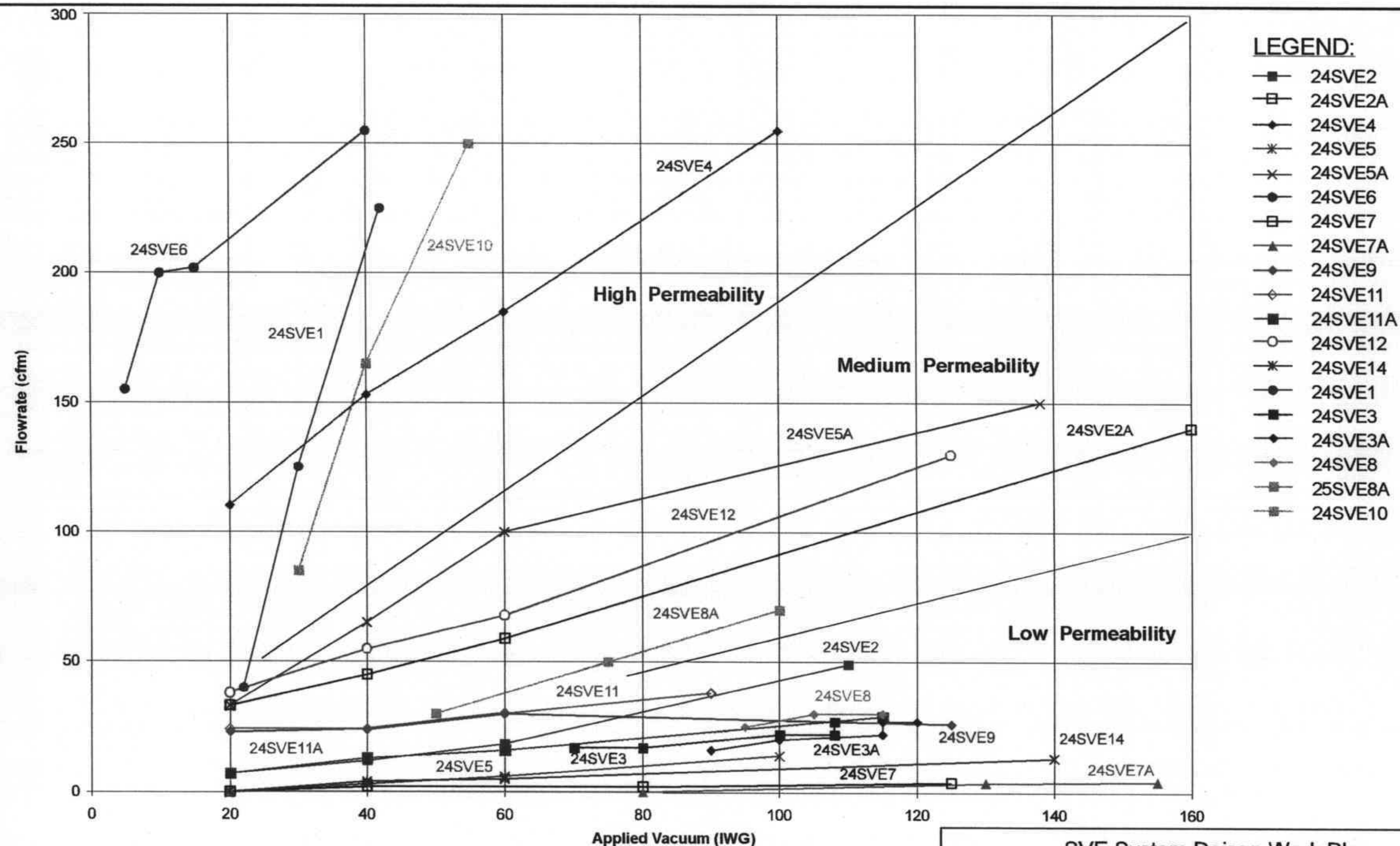
Figure 2-1

Total VOC Mass Removed During Pilot Testing

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 5/1/98
File No: 142C3179
Job No: 22214-142
Rev No: C



SVE System Deisgn Work Plan **Figure 2-2** Flowrate vs. Applied Vacuum Illustrating Permeability Distribution	
MCAS, El Toro, California	
Bechtel National, Inc. CLEAN II Program	Date: 4/27/98 File No: 142C3181 Job No: 22214-162 Rev No: B

SECTION 3

CONCEPTUAL SVE SYSTEM DESIGN

Section 3
CONCEPTUAL SVE SYSTEM DESIGN

This section outlines the approach to the SVE system design. For the purposes of design, the SVE system has been broken into three major parts: the SVE well field, the vapor-conveyance system, and the Norton AFB extraction and emission-abatement system. A vacuum produced by the extraction system is conveyed to the SVE well field through the vapor-conveyance system, and induces soil gas flow toward the SVE wells. VOCs in the soil gas are transported and removed from the subsurface through the SVE wells and conveyance system. The resulting vapor stream is treated to reduce VOC concentrations before its discharge to the atmosphere.

The design approach will be sequential, beginning with the SVE well field design and concluding with the extraction and emission-abatement system design. The sequence of the design activities reflects the dependence of individual parts on each other. A flowchart showing the design sequence is provided in Figure 3-1.

The design of the SVE well field is based primarily on the vertical and lateral extent of VOC contamination and the physical characteristics of the soil media that influence soil air permeability and airflow. The primary design parameter for the SVE well field is the effective radius of influence (EROI), or the zone in which VOCs are efficiently transported to the SVE well. The design EROI, wellhead vacuum, and flow rates are the key parameters resulting from the well field design.

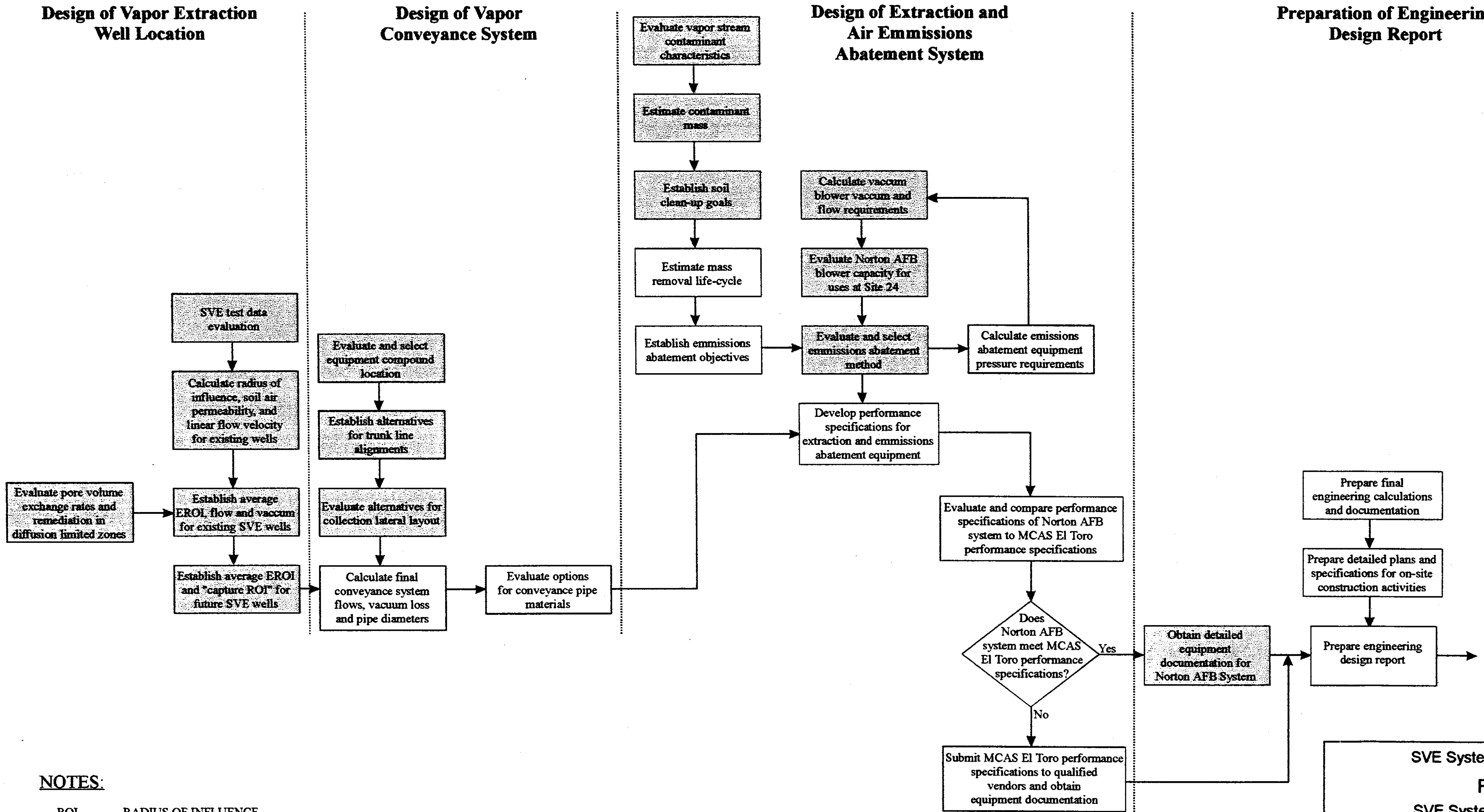
The parameters required for the conveyance system design include the design airflow and wellhead vacuum. The vapor-conveyance system consists of primary collection laterals, intermediate manifolds, and trunk lines that transport the VOC-laden soil gas to the vacuum system. The primary design objective of the vapor-conveyance system is to minimize materials and installation costs while meeting the SVE system performance specifications.

The design of the vacuum system depends primarily upon the SVE wellhead vacuum required to sustain the design flows. Conveyance system vacuum losses and pressure differential requirements for air-emission-abatement equipment are factored into vacuum system design. The capability for operational flexibility is also a major design parameter.

The air-emission-abatement method is selected based on the contaminant characteristics, the expected life-cycle concentrations, the overall mass of contaminants to be treated, and the required treatment efficiency. The sizing of this equipment is primarily a function of flow rate. Additional considerations for the air-emission-abatement equipment are capital costs and operation and maintenance costs.

3.1 SOIL CLEANUP OBJECTIVES

As part of the draft final Interim ROD (BNI 1997b), soil cleanup objectives were defined by threshold soil gas concentrations. The threshold concentrations are minimum soil gas concentration levels that have the potential to contaminate groundwater above the MCLs. Threshold concentrations were calculated based on site-specific and chemical-specific factors. A summary of these threshold concentrations is provided in Table 3-1.



NOTES:

ROI	RADIUS OF INFLUENCE
EROI	EFFECTIVE RADIUS OF INFLUENCE
SVE	SOIL VAPOR EXTRACTION
(shaded box)	TASK COMPLETED OR PARTIALLY COMPLETED

SVE System Design Work Plan

Figure 3-1

SVE System Design Sequence

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 4/29/98
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Table 3-1
Vadose Zone Concentration Threshold Calculations
(results reported in micrograms per liter)

VOC[a] Species	U.S. EPA[b] MCL[c]	Soil Gas Concentration Threshold Result	Highest Soil Gas Concentration Detected
Trichloroethene	5	27	6,120
Tetrachloroethene	5	69	192
Carbon tetrachloride	5	61	31
1,1-dichloroethene	6	563	447
Freon 113	1,200[d]	234,000	2,520

Notes:
[a] VOC – volatile organic compound
[b] U.S. EPA – United States Environmental Protection Agency
[c] MCL – maximum contaminant level
[d] California MCL

Soil cleanup objectives were calculated in the Phase II RI report using site-specific and chemical-specific data. These objectives will be verified during the engineering design phase using VLEACH and MIXCELL, two U.S. EPA modeling programs. The threshold soil gas concentrations shown in Table 3-1 will be used as the soil cleanup objectives for the SVE system design and implementation.

Performance-based criteria are an alternative to soil gas threshold concentrations. When SVE system operation is guided by performance-based criteria, the goal is to reach asymptotic conditions with regard to reduction in VOC concentrations and mass removal. Performance-based criteria will be addressed in the contingency plan.

3.2 NORTON AFB SVE SYSTEM

In 1997, Norton AFB successfully completed remediation of TCE contamination in the vadose zone using SVE. DON has investigated that SVE system and has negotiated to use the aboveground portion of the equipment for remediation at Site 24. The major components of the Norton AFB SVE system are described in the Engineering Design Report (EARTH TECH 1995) and summarized in Table 3-2.

Each element of the Norton AFB system will be evaluated during the engineering design phase and modifications will be made, as required, to meet MCAS El Toro design specifications. Preliminary evaluations indicate that the Norton AFB system has the flexibility to provide the range of airflow and applied vacuum that is expected to be necessary for the Site 24 SVE well field.

Table 3-2
Norton AFB[a] SVE[b] System Equipment List

Equipment	Description
Vacuum blower	two 4,250 scfm[c] positive-displacement blowers with 150-horsepower motors
Vapor-phase activated carbon adsorbers	two 20,000-pound vapor-phase granular activated carbon adsorbers
Other equipment	one air/water moisture separator (Wright-Austin Type TS gas-liquid separator)
	one condensate transfer pump with a capacity of 10 gallons per minute
	one condensate storage tank, cylindrical polyethylene, 7.5 feet in diameter and 6.5 feet high
	one water-cooled heat exchanger, model C/TV-400
	one evaporative cooling tower, model T-40
	one cooling centrifugal pump, model EP 150 3030
	equipment silencers
	miscellaneous controls and electrical equipment

Notes:
[a] AFB – Air Force Base
[b] SVE – soil vapor extraction
[c] scfm – standard cubic feet per minute

3.3 DESIGN OF CONCEPTUAL SVE FIELD

The conceptual well layout for Site 24 was developed based on data obtained during the SVE pilot tests (BNI 1997c). This portion of the Work Plan summarizes the analytical methods used and provides additional detail on how the spacing and number of wells will be established.

3.3.1 Evaluation of SVE Test Data

Between November 1996 and March 1997, OHM conducted a series of soil vapor extraction pilot tests on existing SVE wells. One-day pilot tests included the monitoring of well flow and vacuum response in monitoring wells at variable applied vacuums. Vapor samples were also collected for chemical analysis. Extended pilot tests included continuous extraction and monitoring over a period ranging from 44 to 84 days. A rebound pilot test was also conducted at one well to assess equilibrium (rebound) concentrations and to evaluate the rate of VOC concentration decline during the second period of extraction. The data collected during the pilot tests were evaluated to estimate soil air permeability, pore volume exchange rates, the SVE well ROI, and the relationship between volumetric flow rate and applied vacuum.

Analysis of initial pilot test data revealed that airflow measurements collected with a hot-wire anemometer did not provide as consistent measurements as those made with a rotameter. Therefore, 14 SVE wells were retested in March 1998 using the more accurate rotameter airflow meters to verify the previous hot-wire anemometer airflow measurements. Flow versus applied vacuum curves were plotted using the new data. SVE retest data, in some cases, varied significantly from pilot test data. The differences were attributed to more accurate airflow measuring, and possible increased vadose zone moisture content due to heavy rains. Results are illustrated on Figure 2-2. These data suggest the presence of three permeability ranges at Site 24, which are termed low, medium, and high permeability zones.

3.3.2 Soil Heterogeneity

The three permeability zones generally correspond to stratigraphic layers characterized as fine-grained (silts and clays), medium-grained (silty sand and clayey sand), and coarse-grained (sands and gravels). Fine, medium, and coarse permeability units are defined as having 50 to 100 percent silt/clay, 25 to 49 percent silt/clay, and less than 25 percent silt/clay, respectively. Permeability zones were evaluated at three depth intervals: 0 to 40, 40 to 70, and 70 to 110 feet bgs. Boring logs and cone penetrometer test logs were analyzed to assign the percent of fine-grained soils at these depth intervals. This correlation was used to help design the conceptual SVE well field. As discussed in Section 4 of this Work Plan, further evaluation and testing will be conducted to refine SVE well locations during SVE well installation.

3.3.3 Estimating Effective Radius of Influence

The EROI is a key element in the design of the SVE well field. The EROI is defined as the radius at which a critical airflow velocity is reached (P.E. Stumpf 1992). For the SVE well field design at Site 24, the EROI will be based on a critical velocity of 0.02 feet per minute. A critical velocity of 0.02 feet per minute promotes clean airflow through the vadose zone and is consistent with the Norton AFB SVE design.

An average EROI was estimated for high, medium, and low permeability zones as follows:

1. The ROI at each SVE well was obtained from pilot test data by recording the remote pressure at several nearby SVE wells, if present. The ROI is defined as the radial distance at which the remote pressure is equal to one percent of the applied vacuum. In the event that soil heterogeneity provided inconsistent or no vacuum influence data, "reasonable" vacuum influences were assumed, based on experience. The ROI ranged from 50 to 460 feet.
2. Once the radius of influence was estimated, the soil permeability to airflow was calculated using the following formula:

$$K = \frac{Q \mu \ln(R_w / R_i)}{H \pi P_w \left[1 - (P_{atm} / P_w)^2\right]}$$ Equation 3.1

where:

K = soil permeability to airflow (square centimeters)
Q = volumetric flow rate (cubic centimeters per second [cm^3/s])
μ = viscosity of air (grams per centimeter per second [g/cm-s])
R_w = radius of well (centimeters)
R_i = radius of influence (centimeters)
H = well screen length (centimeters)
P_w = absolute pressure at SVE well (grams per centimeter per square seconds [$g/cm\text{-}s^2$])
P_{atm} = absolute ambient pressure ($g/cm\text{-}s^2$)

The equation was derived from the steady-state radial flow solution for compressible flow (Johnson et al. 1990a).

Soil permeability to airflow was calculated for deep zone SVE wells. The permeability ranged between 1.7×10^{-7} and 7.8×10^{-10} square centimeters, which is consistent with fine and medium sands, and clays (Johnson et al. 1990a).

3. After the soil permeability had been calculated, the following equation was used to calculate linear soil gas velocity in centimeters per second (cm/s) as a function of radial distance from the SVE well (Johnson et al. 1990b):

$$U(r) = -\frac{K}{2\mu e} \frac{\left(\frac{P_w}{r \ln(R_w / R_i)}\right) \left[1 - \left(\frac{P_{atm}}{P_w}\right)^2\right]}{\left\{1 + \left[1 - \left(\frac{P_{atm}}{P_w}\right)^2\right] \frac{\ln(r / R_w)}{\ln(R_w / R_i)}\right\}^{1/2}}$$ Equation 3.2

where:

U(r) = linear soil gas velocity (cm/s)
r = radial distance away from well (feet)
e = soil porosity (dimensionless)

Linear soil gas velocities were calculated for various radii. The estimated EROI was based on a minimum critical velocity of 0.02 feet/minute. (0.0102 cm/s), (Stumpf 1992). The "critical velocity" was selected to promote airflow. EROI is defined as the radius where the critical velocity is reached.

Average EROIs were calculated for high, medium, and low permeability zones using pilot test data from SVE wells in the deep zone (70 to 110 feet bgs). EROIs were tabulated by permeability zone and averaged. Two wells within the high permeability contours had unusually low EROIs. Data for these wells reduced the average EROI calculated for the high permeability zone.

"Reasonable" SVE influence ROIs were assumed when inconsistent and/or unreasonable vacuum influence was encountered. These assumptions have a small effect on the EROI calculations because the natural log of the quotient (R_w/R_i) does not greatly affect U(r) in Equation 3.2. SVE airflow is the most significant variable that appears in the equation for soil permeability. Table 3-3 summarizes the EROI estimates.

EROIs were further rounded to the following values:

- High permeability – 200 feet;
- Medium permeability – 45 feet; and
- Low permeability – 30 feet.

3. To optimize the preliminary SVE well placement, the EROI spacing was used in areas that have soil gas concentrations greater than 500 µg/L, and in areas that have soil contamination greater than 30 µg/kg. For areas of lower soil gas and soil concentrations, or "nonsource areas," the low and medium EROIs were doubled, and the high permeability capture ROI was increased to 1.5 times the EROI. Slower airflow velocities (less than critical velocity) were considered acceptable in these areas due to lower soil and soil gas contamination, which is assumed to require exchange of fewer advective pore volumes than the more highly contaminated areas. The nonsource area EROIs are referred to as "capture ROIs."

   The nonsource area capture ROIs were plotted relative to permeability contours and contaminant concentrations. Increases in soil permeability due to reduction in soil moisture during operation are expected to expand SVE capture radii over time. The design nonsource area capture ROIs are as follows:

   - High permeability – 300 feet;
   - Medium permeability – 90 feet; and
   - Low permeability – 60 feet.

Once the EROI and nonsource area capture ROIs were calculated for each permeability zone, a preliminary well field layout was configured by overlaying an outline of the SVE well radii over contour maps showing TCE concentrations and soil permeabilities in the shallow, intermediate, and deep zones (Figures 3-2 through 3-4). The ring surrounding each well in Figures 3-2 through 3-4 indicates the assumed EROI or capture ROI. Low and medium permeability zones have greater pore volume exchange rates than the high permeability zone to facilitate diffusion-limited removal of VOCs.

The conceptual SVE well field includes a total of 214 wells (including existing wells): 25 screened within the shallow zone, 88 screened within the intermediate zone, and 101 screened within the deep zone. Because of the heterogeneous nature of soil at Site 24, the exact number and location of wells cannot be fixed at this time. Instead, well installation will follow a phased approach, with only 30 percent of the wells installed in

Table 3-3
Effective Radius of Influence Averages

High Permeability Wells	EROI* (feet)	Medium Permeability Wells	EROI (feet)	Low Permeability Wells	EROI (feet)
24SVE7	5	24SVE11	45	24SVE2	30
24SVE1	320	24SVE3	35	24SVE3	35
24SVE6	380	24SVE8	60	24SVE14	17
24SVE4	340	24SVE9	55		
24SVE10	300	24SVE2	30		
24SVE5	25	24SVE5	25		
Average EROI	228		43		28

Note:
* EROI – *effective radius of influence*

the first phase. The number and location of the remaining wells will be based on field observations during installation and field testing. Section 4.1 provides additional detail on well installation and testing.

3.3.4 Other Design Considerations

Other parameters that will be considered part of the SVE well field design include:

- low permeable surface cover (e.g., pavement);
- pore volume exchange rate; and
- diffusion limited transport of VOCs through low permeability zones.

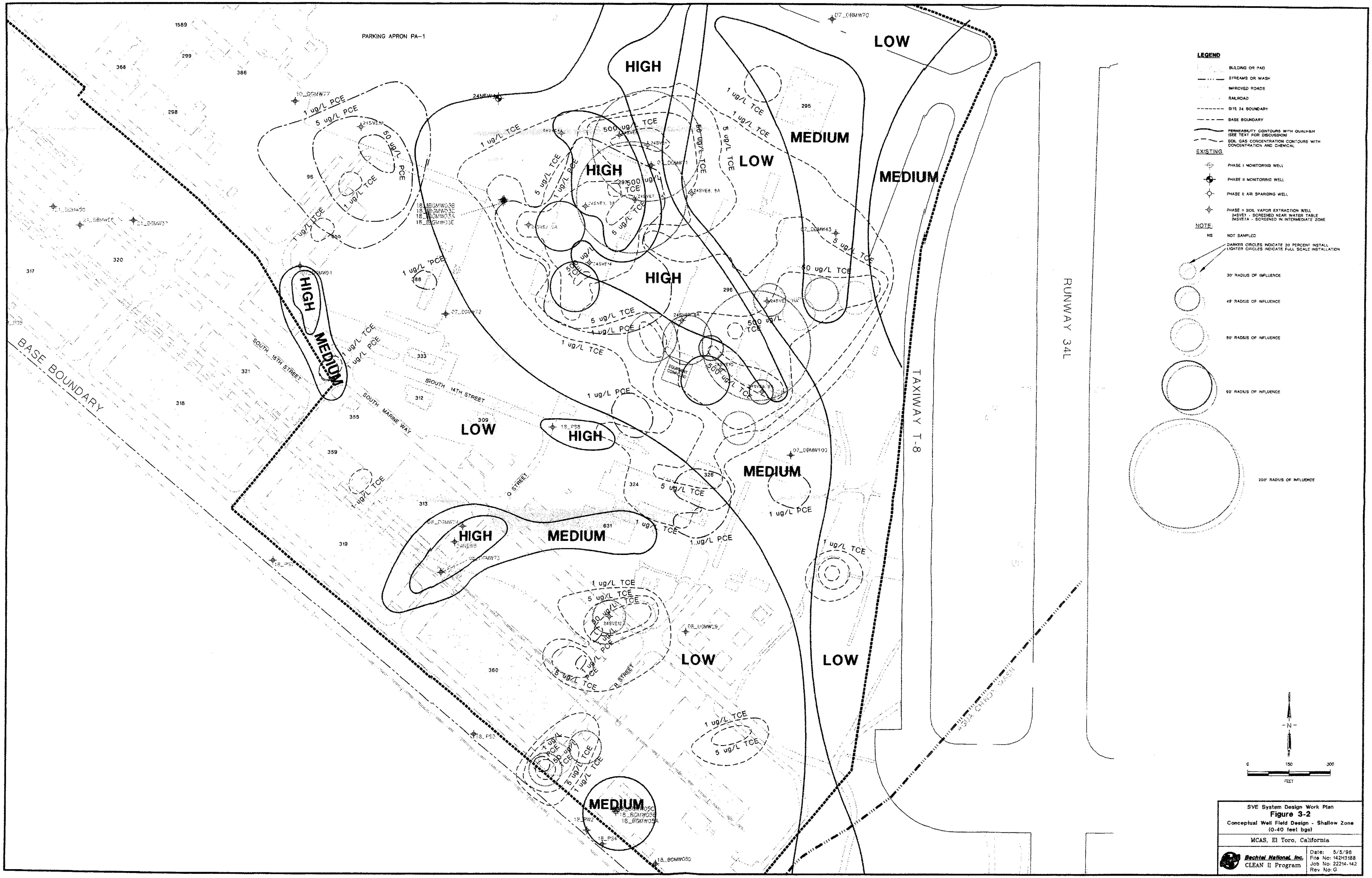
These parameters may affect increases or decreases in the design EROI, flow and vacuum, and the placement and design of future SVE wells.

3.4 DESIGN OF VAPOR-CONVEYANCE SYSTEM

The vapor-conveyance system will include the trunk lines and collection laterals that carry vapors extracted from the SVE wells to the extraction and air-emission-abatement equipment. The primary design activities for the conveyance system will include selection of the equipment compound location, selection of the main trunk line locations, lateral collection system layout, and pipe sizing. These activities are discussed in more detail below.

3.4.1 Selection of Equipment Compound Location

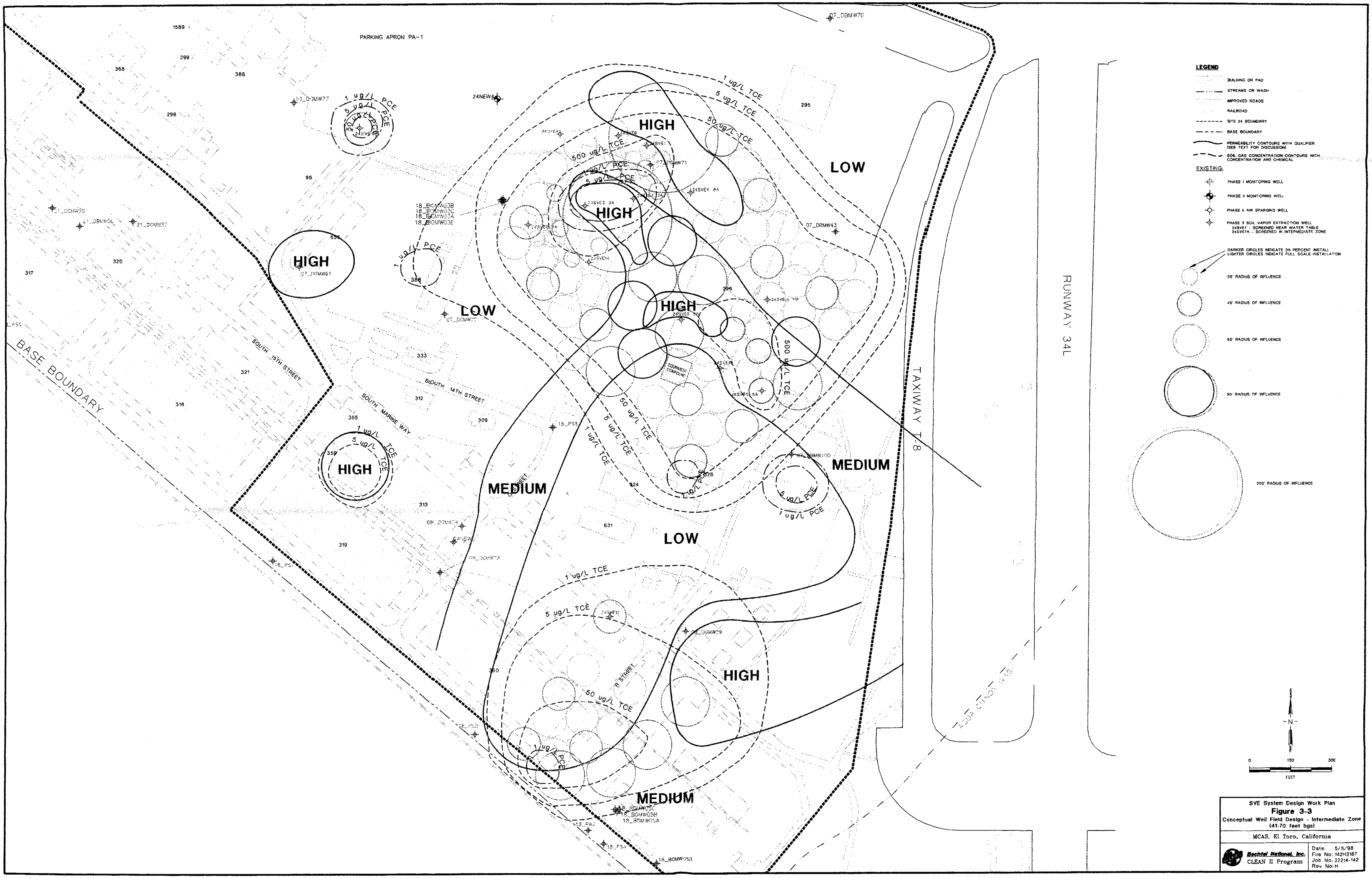
The equipment compound location is currently planned for the southwest corner of Building 296. This location was chosen based on the following criteria:



SVE System Design Work Plan

Figure 3-2

Conceptual Well Field Design - Shallow Zone (0-40 feet bgs)



SVE System Design Work Plan

Figure 3-3

Conceptual Well Field Design - Intermediate Zone (41-70 feet bgs)

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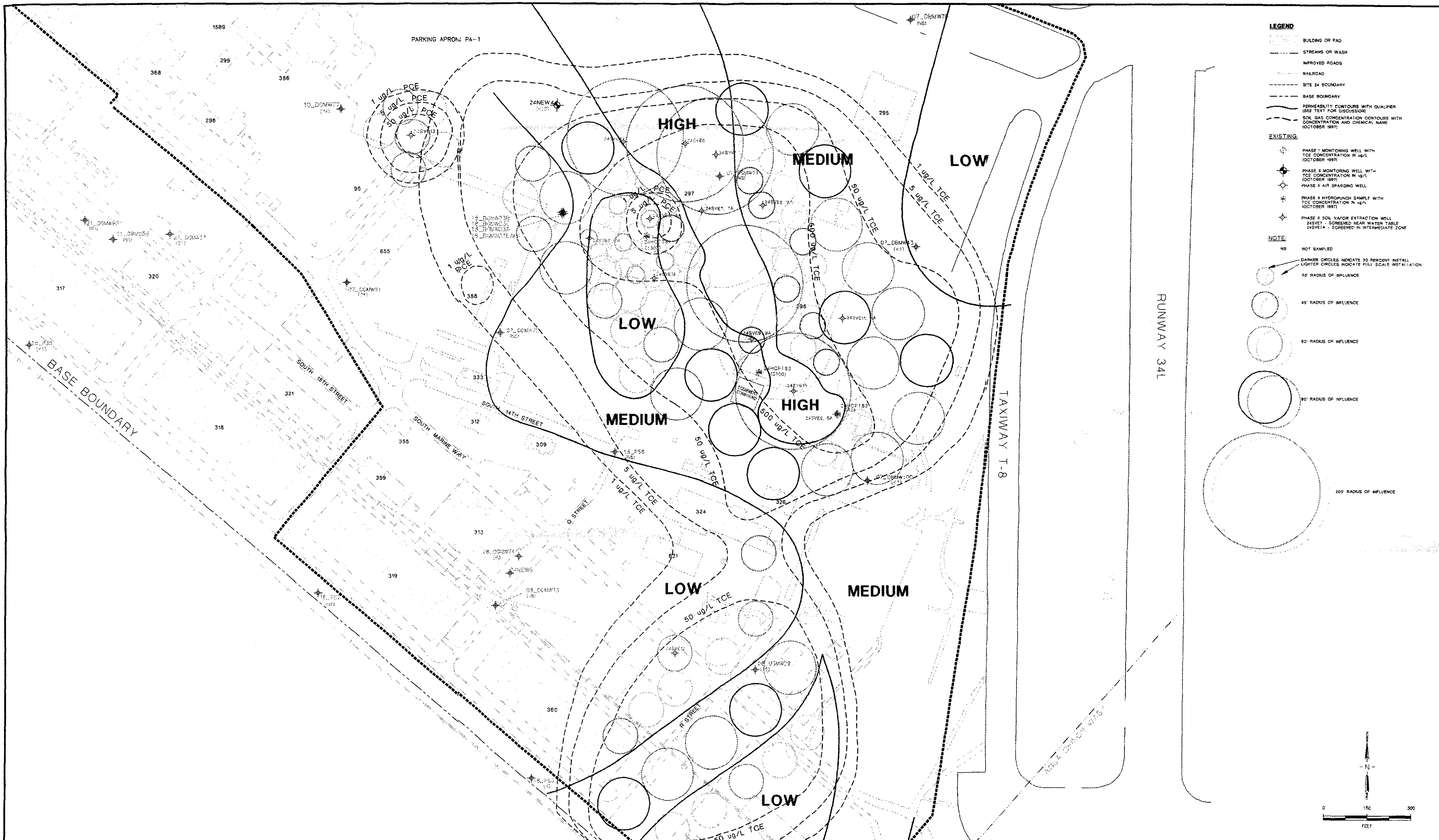
Rev No: H



SVE System Design Work Plan

Figure 3-4

Conceptual Well Field Design - Deep Zone (71-100 feet bgs)

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Job No: 22214-162
Rev No: I

- availability of space;
- compatibility with current and potential future land use;
- proximity to the SVE well field;
- proximity to existing electrical services;
- accessibility; and
- off-site impacts.

In selecting the equipment compound location, emphasis was on minimizing the SVE system installation and O&M costs by minimizing trunk line lengths, minimizing electrical service installation costs, and maximizing accessibility.

The skid-mounted system will be installed within a fenced area. It is assumed that the treatment facility will have dimensions similar to those of the Norton AFB system, approximately 90 by 90 feet, and will include a 43- by 17-foot concrete containment area for the air/water separator and condensate storage tank. The remaining skid-mounted equipment will be placed directly on the existing concrete surface.

It was assumed that conveyance plumbing in the vicinity of Buildings 296 and 297 will be installed in subgrade trenches resurfaced to match the existing pavement. However, depending on access requirements and planned activity around Buildings 296 and 297, some pipe lengths may be installed aboveground. It is assumed that power to the treatment facility will be provided by the existing service at Building 296.

3.4.2 Selection of Main Trunk Line Alignments

The main trunk lines will convey the extracted vapors from the collection laterals to the extraction and air-emission-abatement equipment. These lines will serve as the main conveyance artery for the SVE wells. Because trunk line and collection lateral installation may represent a significant portion of the SVE system installation costs, minimization of the trunk line and vapor-collection lateral length and belowground installation will be an important consideration in selecting the trunk line alignment. Other factors that will be considered include:

- potential locations of future SVE wells;
- anticipated location of trunk lines for the groundwater system;
- current and potential future land uses; and
- use of existing corridors such as roadways or alleys.

3.4.3 Vapor-Collection Manifolds and Laterals

The vapor-collection manifolds and laterals will convey the extracted vapors from the SVE wellheads to the trunk lines. Several configurations may be possible, depending on the location of the trunk lines and the layout of the SVE well field. Potential configurations may include:

- independent laterals for each SVE well extending to the trunk lines;
- independent laterals for groups of SVE wells linked together by an intermediate manifold; and
- serial linking of SVE wells with progressively larger pipes leading to the main trunk lines.

Potential vapor-collection lateral configurations will be evaluated with respect to the following criteria:

- minimizing the total collection lateral length;
- minimizing belowground installation;
- equalizing the vacuum at wellheads;
- minimizing vacuum losses;
- minimizing pipe diameters;
- minimizing maintenance and monitoring time; and
- facilitating current and potential future land uses.

3.4.4 Conveyance System Pipe Sizing

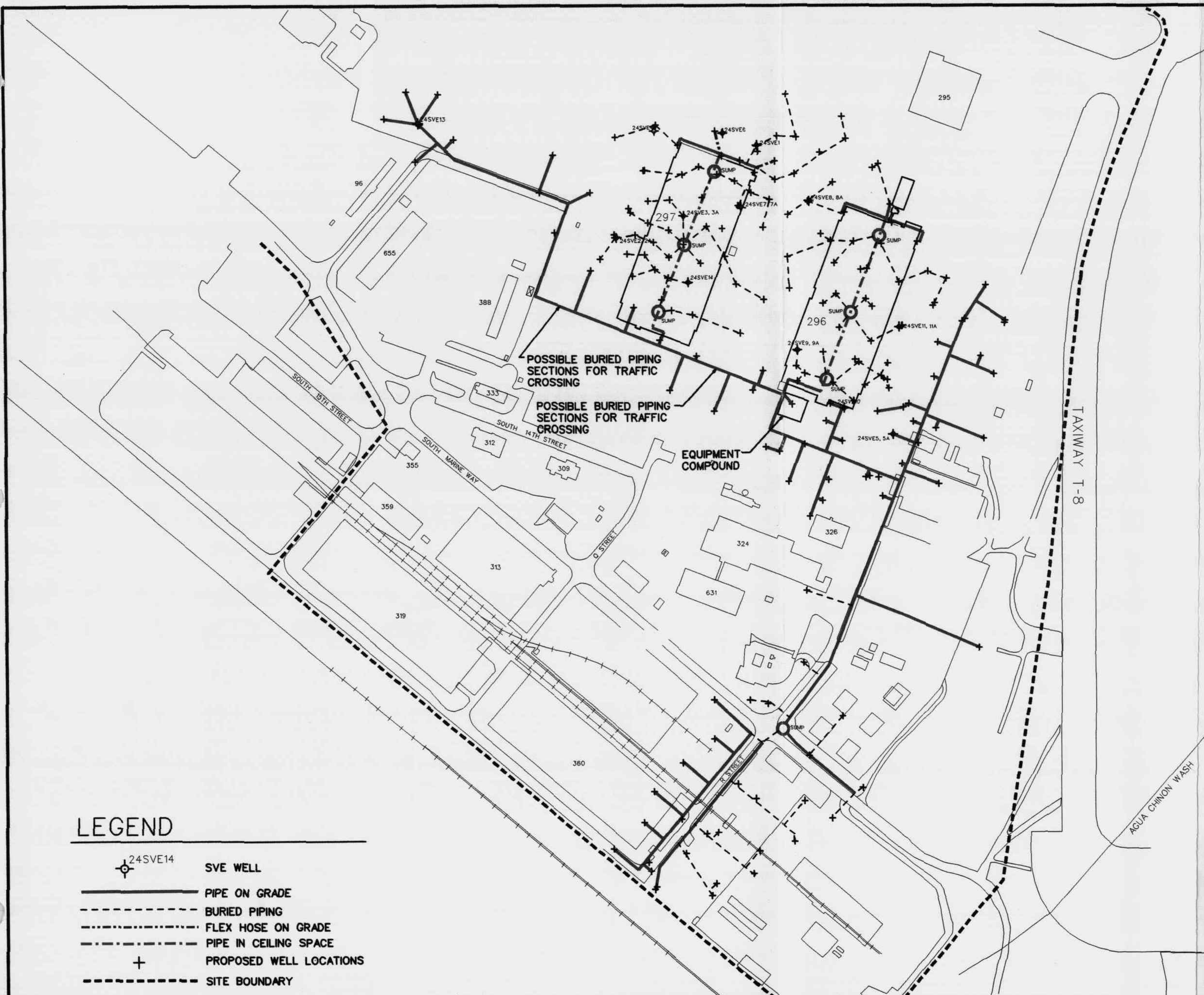
The layout of the piping system will be driven by both the placement of extraction wells and the need to minimize interference with ongoing Station operations. A conceptual piping layout is shown in Figure 3-5. The piping layout will be finalized in the EDR. Once the final conveyance system layout has been established, line sizing calculations will be performed to determine appropriate pipe diameters to minimize line loss and material cost at the predicted vacuum pressure and well production conditions.

3.4.5 Materials

Alternative piping materials will be considered for the conveyance system. The primary considerations for the selection of piping materials will be chemical compatibility with the anticipated vapor stream, pipe and fitting costs, material durability, and availability. Although other material will be considered, it is currently anticipated that Schedule 40 and Schedule 80 polyvinyl chloride piping will be used for most of the vapor-conveyance system.

3.5 IMPACT OF LOW PERMEABILITY SURFACE COVERS ON SVE WELL DESIGN

Much of the surface at Site 24 is covered with low permeability covers such as asphalt, concrete aprons, and concrete building slabs (Figure 3-6). These surface covers can



SVE System Design Work Plan

Figure 3-5

Conceptual Pipe Layout
Central Treatment Facility

MCAS, El Toro, California

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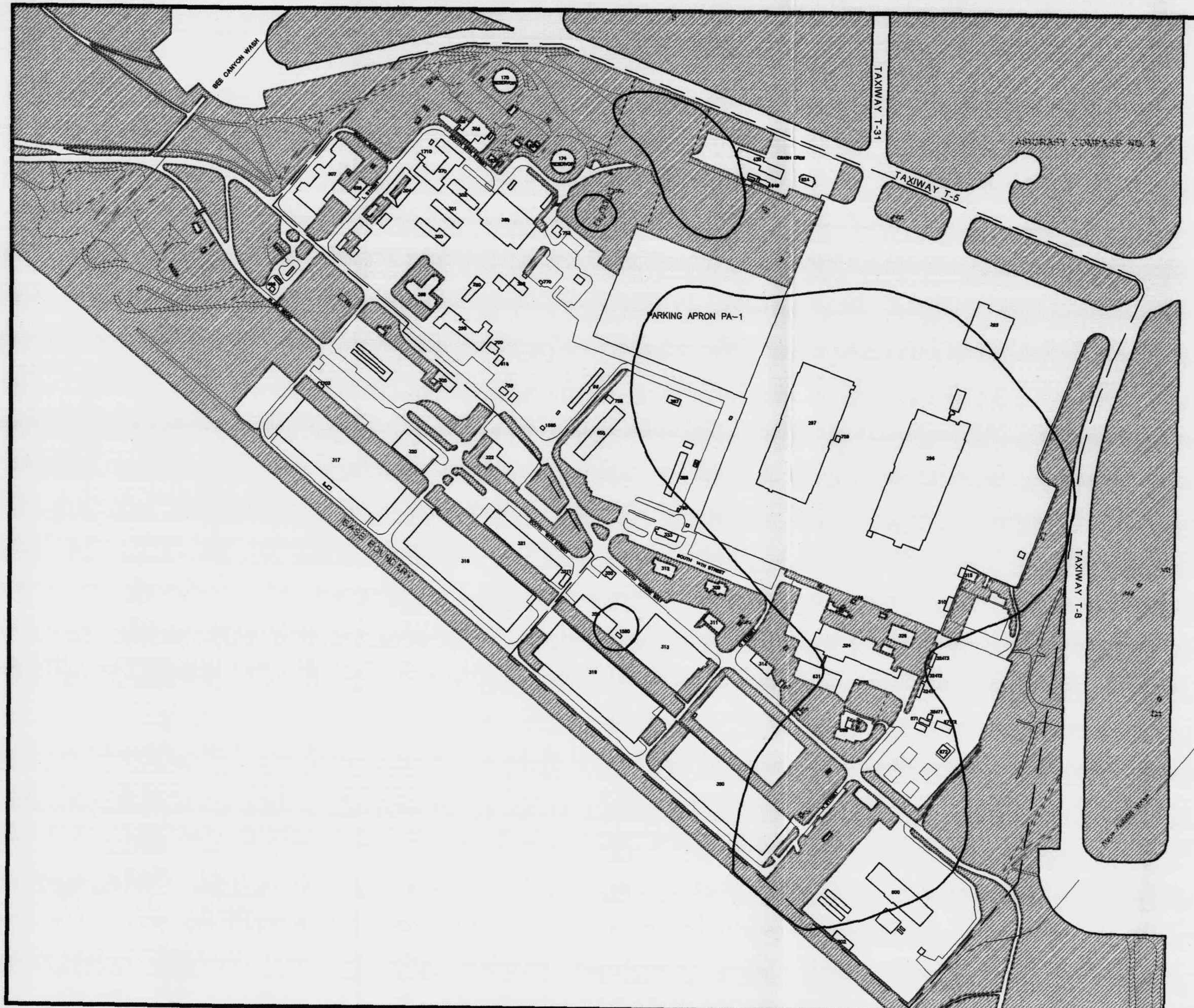
Job No. 22214-142



LEGEND

- 313 — BUILDING OR PAD
- STREAMS OR WASH
- IMPROVED ROADS
- RAILROAD
- SITE 24 BOUNDARY
- BASE BOUNDARY
- LOW PERMEABLE SURFACE COVER
- BARE SOIL OR LANDSCAPING
- 1 ug/L ISOCONCENTRATION CONTOUR FOR TCE IN SOIL GAS NEAR THE WATER TABLE

NORTH — N — TRUE

0 450 900
FEET

SVE System Design Work Plan

Figure 3-6

Site 24 - Low Permeable Surface Cover

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Job No: 22214-142
Rev No: D

affect or reshape the ROIs, especially for shallow SVE wells. Under some conditions, vent wells may need to be considered to aid or reshape the soil gas extraction patterns. The need for such vent wells will be addressed in the EDR (BNI, in preparation).

3.6 DESIGN OF EXTRACTION AND AIR-EMISSION-ABATEMENT SYSTEM

Based on the success of the SVE system at Norton AFB, the availability of the system, and preliminary review of system performance, the DON has elected to use the Norton AFB system for remediation of Site 24. Because the performance specifications of the extraction and air-emission-abatement system are contingent upon the design vacuum and flow rate and the anticipated life-cycle concentration of VOCs in the extracted vapor stream, it is necessary to assess the Norton AFB system components using site-specific data from Site 24. In some cases, it may be necessary to make modifications to the Norton system to accommodate the conditions at MCAS El Toro. The sections that follow discuss the Norton AFB system components and the process that has been or will be used to evaluate the effectiveness of these components at Site 24.

3.6.1 Blower System Performance Evaluation

Preliminary assessment of the Norton AFB blower indicates flexibility sufficient to address expected changes in applied vacuum and extracted airflow.

The Norton AFB SVE system uses two 4,250-standard cubic feet per minute positive-displacement blowers with 150-horsepower motors to provide vacuum for the SVE wells. As part of the piping system design, the capabilities of the blower system will be evaluated with respect to the anticipated vapor production rate from the well field. Since the vapor production from each well is dependent upon the wellhead vacuum pressure; the wellhead vacuum pressure is dependent upon the piping pressure drop and the blower performance; and the blower performance is dependent upon the total well productivity, each of these elements must be predicted in conjunction with the others. For this reason, the performance of the blower, the distribution of vacuum pressure throughout the piping system, and the number of and delivery from the SVE wells will be calculated at the same time using a spreadsheet approach in an iterative fashion. The following will be included in the spreadsheet model:

- the production characteristics for wells of low, medium, and high permeability;
- the sizing and physical configuration of the distribution piping; and
- the blower system performance as a function of throughput.

This model will also be used to evaluate system performance in the 30 percent startup phase, prior to installation of the remaining well field.

3.6.2 Emission-Abatement Equipment Performance Evaluation

The Norton AFB SVE system uses two 20,000-pound vapor-phase GAC adsorber units and an air-cooling unit for vapor stream emission abatement. Preliminary assessment of the Norton AFB system indicates that operational requirements (e.g., vapor stream flow rate, contaminant concentrations, vacuums) for MCAS El Toro are similar to those presented in the Norton GAC design specifications. SVE system design will include a vapor stream evaluation and an estimation of GAC loading rates. Calculations will be performed to verify compliance with applicable SCAQMD discharge requirements.

DON plans to measure emissions using an organic vapor analyzer (e.g., photoionization detector or flame ionization detector). Samples will be taken from the inlet to the primary adsorber, outlet of the primary adsorber, and outlet of the secondary adsorber. In accordance with SCAQMD guidelines, the lead vessel effluent and system effluent will be sampled periodically during the first 48 hours at the inlet to the primary adsorber, outlet of the primary adsorber, and outlet of the secondary adsorber. After the first 48 hours, VOC concentrations will be measured at the outlet of the primary and secondary adsorbers at least once every operating day for the first 2 weeks and weekly thereafter unless calculation of carbon loading shows the need for more frequent sampling.

Once the system is in full operation, samples will be collected from the inlet of the primary and at the outlets of the primary and secondary adsorbers using Summa™ canisters or Tedlar™ bags. These samples will be sent to a fixed-based laboratory for analysis using U.S. EPA Method TO-14. The results will be used to confirm the results of the risk assessment performed in the Permit Equivalency Package.

3.6.3 Auxiliary Equipment

In addition to the auxiliary equipment included in the Norton AFB package, some additional hardware will be required. As a minimum, condensate transfer pumps, process control and monitoring equipment will be considered. Depending on the results of the blower system performance evaluation, equipment to supplement the existing capacity may be required. This may consist of booster pumps, tankage, treatment equipment, or some combination of these. Specific needs and sizing will be addressed as detailed engineering design proceeds.

SECTION 4

SVE SYSTEM INSTALLATION AND OPERATION

Section 4
SVE SYSTEM INSTALLATION AND OPERATION

This section describes the approach that is proposed for SVE well field installation and testing, and for SVE system O&M and monitoring. More detailed information will be provided in the EDR and the O&M Manual. Both documents are currently in preparation.

4.1 WELL INSTALLATION AND TESTING

It is proposed to install the SVE well field using a phased, 30 percent/70 percent approach. The proposed SVE wells that are part of the initial 30 percent installation are shown with bolded EROIs and capture ROIs in Figures 3-2 through 3-4. These well borings will be continuously cored to produce detailed stratigraphic profiles. Each well will be tested to evaluate the relationship between applied vacuum and extracted airflow. ROI will be estimated using remote vacuum data or based on the applied vacuum/airflow relationship.

Well spacing may preclude measurement of remote vacuum in some cases so that the ROI cannot be estimated graphically. However, EROI is estimated using the natural log of the quotient (R_w/R_i) and is not particularly sensitive to this term.

As the initial 30 percent installation is completed, the wells will be tested as described below. Results will be used to plot the refined EROI estimates and locate additional SVE wells. SVE wells will be drilled and tested in three groups: the Building 296 area; the Building 297 area, including the PCE plume; and the area south of Building 296.

The proposed SVE well tests will last approximately 2 hours at each SVE well. The starting vacuum should be the maximum vacuum obtainable with no dilution or recirculation. This vacuum should be maintained for 30 minutes. Pressure and airflow should be measured every 10 minutes at the extraction wells. The maximum vacuum should then be divided by four to obtain three additional data sets. For example, if the maximum applied vacuum is 100 inches water gauge (IWG), additional data sets would be recorded using 75, 50, and 25 IWG applied vacuum. The vacuum should then be decreased to the next step and held for one-half hour. Measurements should then be recorded as before. Vacuum influence from surrounding SVE wells and monitoring points should be recorded at the end of the half-hour increment. Criteria for well installation follows.

- If airflow and vacuum influence conditions meet the expected design, the remaining proposed wells will be constructed.
- If the flow is lower than expected, and/or if poor vacuum influence is encountered, additional wells will be installed to reduce well spacing.
- If higher-than-expected flow and/or high vacuum influences are encountered, then the proposed well spacing will be increased according to the higher-than-expected EROI.

The first SVE wells will be placed in the deep zone in areas with similar permeability. Mid- and shallow-zone SVE wells may also be installed in the test group to estimate vertical SVE influence.

Well installation is expected to take approximately 6 months and can be performed in parallel with installation of the piping network. Once all SVE wells have been installed, system start-up can begin.

Low permeability areas are expected to require the greatest exchange of advective pore volumes. This has already been incorporated into the conceptual design. If ROI estimates show that very low permeability zones (e.g., less than 20 feet ROI) are present, these areas will be evaluated for SVE technology enhancements, such as converting SVE wells to air injection wells or using pneumatic soil fracturing. These and other system optimization techniques will be discussed in the Contingency Plan.

4.2 OPERATIONAL APPROACH

The Norton AFB SVE treatment system is rated for a maximum of 10,000 cubic feet per minute (cfm). Pressure drop across system components such as the inlet silencer, knockout pot, carbon filters, and conveyance piping reduces the maximum operational airflow to approximately 8,000 cfm at an applied vacuum of 60 IWG. With all of the proposed SVE wells operating at Site 24, the maximum SVE wellhead vacuum available is expected to be in the 60 to 80 IWG range. As noted in Table 4-1, some low and medium permeability wells will require a higher vacuum (in the 130- to 140-IWG range) to achieve a reasonable EROI. Therefore, the recommended operational approach is to initially place all wells in service, then as the vapor stream extracted from individual SVE wells reaches low contaminant concentrations (i.e., lower than the threshold value), those wells will be taken out of service. When SVE wells are placed off-service, they should be free-vented to atmosphere to improve air infiltration and flow. As total system airflow is reduced, the available SVE header vacuum will be increased. This will allow low permeability wells to operate at a higher vacuum. The system blowers will be modified to optimize vacuum performance at the lower airflows, as applicable.

Based on the preliminary well field layout, total SVE airflow is estimated to range from 7,000 to 9,000 cfm. The required vacuum for individual SVE well operation varies with soil permeability. The ranges of airflow and vacuum and their respective averages for the three permeability ranges are noted in Table 4-1.

The O&M Manual (BNI, in preparation) will detail the operational approach, including planned maintenance, sampling, and decision trees for adjusting flow from the well field and conducting rebound evaluations.

Table 4-1
Average SVE[a] Airflow and Vacuum

Permeability Range	Vacuum Range (IWG)[b]	Average Vacuum (IWG)	Airflow (cfm)[c]	Average Airflow (cfm)
Low	60 –140	103	13 – 22	18
Medium	60 – 138	92	14.5 – 30	22
High	42 – 60	47	180 – 255	228

Notes:
[a] SVE – soil vapor extraction
[b] IWG – inches water gauge
[c] cfm – cubic feet per minute

4.3 OPERATION, MAINTENANCE, AND MONITORING

O&M and monitoring will be addressed in the Operations and Maintenance (O&M) Manual (BNI, in preparation). It is anticipated that the SVE system will be operated continuously at the start of remediation and based on monitoring data will be optimized to maximize the extracted VOC concentrations. As high permeability wells begin to produce TCE concentrations less than the threshold level, they will be valved off and used as clean air inlets. This will permit a higher vacuum to be applied to the lower permeability wells and will facilitate production of a higher flow rate. When VOC concentrations approach asymptotic conditions, the system will be operated in a pulsed mode to evaluate and address any "rebound effect." Vadose zone conditions will be assessed at monitoring points installed specifically to monitor the effectiveness of the SVE system. Once monitoring shows that VOCs in the soil gas have been reduced below concentrations capable of contaminating groundwater above the MCLs (threshold concentrations), or if performance-based criteria are met, soil gas samples will be collected to confirm that no further SVE is required. Soil gas sampling is preferred over soil sampling because it is easier to detect VOCs at low levels in soil gas and because TCE concentrations in soil are already very low at Site 24 (Section 1.6). During the Phase II RI, the detection rate for TCE in soil gas was 53 percent compared to 41 percent for soil. Detection rates for PCE and 1,1-DCE were also higher in soil gas.

Groundwater remediation is expected to take longer than remediation of soils. To assure that soils above groundwater are not recontaminated in the interim between remediation of the vadose zone and groundwater, the vadose zone will be resampled at the conclusion of groundwater remediation. If average soil gas concentrations are found to be above the threshold limits, additional vadose zone remediation may be necessary.

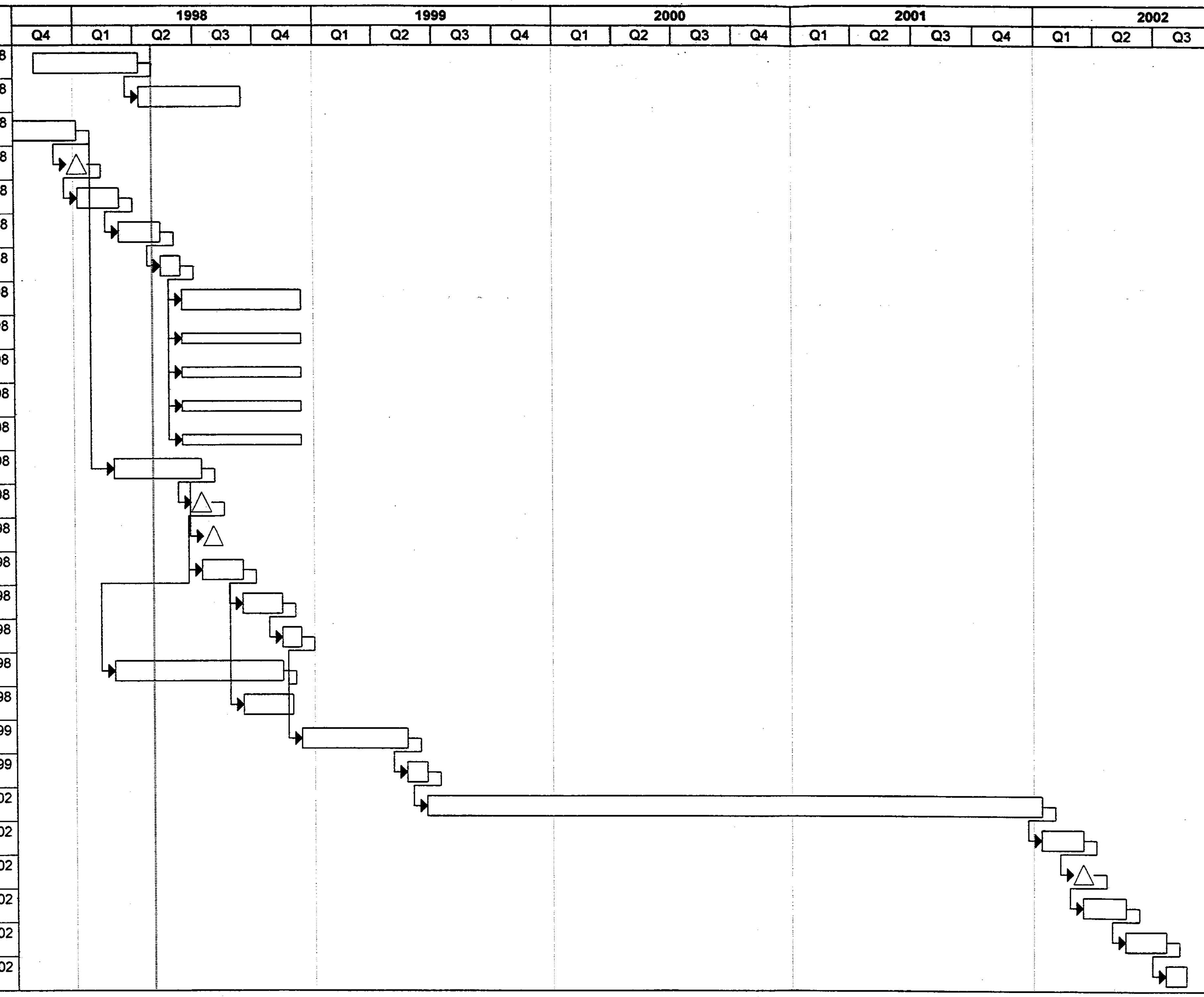
SECTION 5

SCHEDULE

Section 5
SCHEDULE

This section presents the post-ROD schedule for soil remediation at Site 24. The schedule is presented as Figure 5-1.

ID	Task Name	Duration	Start	End
1	Procure Norton SVE Treatment System	158d	11/3/97	4/10/98
2	Move/Setup Norton Treatment System	157d	4/10/98	9/14/98
3	Develop RD/RA Work Plan	97d	10/1/97	1/6/98
4	* Issue Draft RD/RA Work Plan	0d	1/6/98	1/6/98
5	Agency Review	63d	1/6/98	3/10/98
6	Final RD/RA Work Plan	62d	3/10/98	5/11/98
7	Agency Approves RD/RA Work Plan	30d	5/11/98	6/10/98
8	Review/Revise Plans (as necessary)	183d	6/12/98	12/12/98
9	Field Sampling Plan	183d	6/12/98	12/12/98
10	Quality Assurance Project Plan	183d	6/12/98	12/12/98
11	Health and Safety Plan	183d	6/12/98	12/12/98
12	Site Management Plan	183d	6/12/98	12/12/98
13	Develop draft RD Package	132d	3/1/98	7/11/98
14	* Issue draft RD Package	0d	7/11/98	7/11/98
15	* Issue draft Contingency Plan, Constr. QA/QC, and O&M Manual	0d	7/29/98	7/29/98
16	Agency Review	64d	7/11/98	9/13/98
17	Develop draft Final RD, Constr. QA/QC, and Contingency Plans	61d	9/13/98	11/13/98
18	Agency Approves Final RD, Constr. QA/QC, and Contingency Plans	29d	11/13/98	12/12/98
19	Permit Equivalent Process	257d	3/1/98	11/13/98
20	Issue Fact Sheet	76d	9/13/98	11/28/98
21	Installation of SVE System	161d	12/12/98	5/22/99
22	System Check List & Approval	30d	5/22/99	6/21/99
23	Operate & Maintain System	937d	6/21/99	1/13/02
24	Develop Draft Project Closeout Report	63d	1/13/02	3/17/02
25	* Issue Draft Project Closeout Report	0d	3/17/02	3/17/02
26	Agency Review	65d	3/17/02	5/21/02
27	Develop Final Closeout Rpt	61d	5/21/02	7/21/02
28	Agency Approves Final Closeout Rpt	31d	7/21/02	8/21/02



SVE System Design Work Plan

Figure 5-1

Post-ROD Schedule for Site 24 Remediation

MCAS, El Toro, California

Bechtel National, Inc.
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Date: 4/30/98
File No: -
Job No: 22214-142
Rev No: A

SECTION 6

REFERENCES

Section 6
REFERENCES

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APPENDIX A

PRELIMINARY CONTENTS OF ENGINEERING DESIGN REPORT

Appendix A
PRELIMINARY CONTENTS OF ENGINEERING DESIGN REPORT

A detailed design report documenting the soil vapor extraction (SVE) system design process will be prepared prior to system construction. The design report will be a stand-alone document that will include the following discussions:

- site background and history;
- the Feasibility Study process and results;
- the remedial action cleanup objectives and discharge requirements;
- the engineering design process and results, including identification of key design objectives and calculations;
- performance specifications for materials and equipment procurement;
- operation, maintenance, and monitoring procedures; and
- plans and specifications for on-site construction of equipment compound and conveyance system.

A preliminary outline for the design report is provided below.

Preliminary Outline for SVE System Design Report

1 Introduction
 1.1 Objective
 1.2 Project Description
 1.3 Site Description
 1.4 Current and Future Land Use
2 Remedial Action Objectives
 2.1 Remedial Action Objectives
 2.2 Soil Cleanup Objectives
 2.3 Transportation Treatment Standards and Discharge Requirements
 2.4 Other Applicable or Relevant and Appropriate Requirements
 2.5 Air Discharge Permit Equivalency Package
3 SVE System Design
 3.1 Site Background Information
  3.1.1 Site Investigations
  3.1.2 Lithologic Data

3.1.3 Sources of Contamination
3.1.4 Nature and Extent of Contamination
3.2 Contaminant Volume Inventory
3.3 SVE Pilot Test Results
3.3.1 Soil Heterogeneity
3.3.2 One-Day Tests
3.3.3 Long-Term Tests
3.3.4 Rebound Test
3.3.5 SVE Retest
3.3.6 Calculation of SVE Well Performance Parameters
3.4 Vapor Extraction Well Field Design
3.4.1 Design Criteria
3.4.2 Venting Well Locations
3.4.3 Well Design Details
3.5 Vapor Extraction Piping Network
3.5.1 Design Criteria
3.5.2 Piping Layout
3.5.3 Extraction Piping Design Details
3.6 Evaluation of Norton AFB SVE Equipment
3.6.1 Design Criteria
3.6.2 Codes, Standards, and Regulations
3.6.3 Evaluation of Blower
3.6.4 Evaluation of Heat Exchanger
3.7 Treatment Compound
3.7.1 Design Criteria
3.7.2 Location of Compound
3.7.3 Utilities Design
3.7.4 Foundation and Pad Engineering
3.7.5 Process Piping Supports and Equipment Holddowns

3.7.6 Control of Run-on and Runoff

3.7.7 Security

4 Implementation

4.1 Premobilization and Site Preparation

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4.1.2 Topographic Survey

4.1.3 Utilities Mapping

4.2 SVE Well Installation

4.2.1 Wellbore Installation and Sampling

4.2.2 SVE Well Construction

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4.4 Piping Manifold Construction

4.4.1 Materials and Equipment

4.4.2 Construction of Manifolds

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4.5.2 Pad Installation

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4.6.2 Temporary Electrical Services

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4.6.4 Internal Wiring of System Components

4.7 Equipment Procurement and Installation

4.7.1 Procurement of Norton AFB SVE System

4.7.2 Transportation to Site

4.7.3 Equipment Placement in Compound

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4.8 General

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5.1.2 Condensate Collection Subsystem

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6.2 Confirmation Sampling

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7.1 Piping Abandonment

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8.1 Laboratory Analysis Report

8.2 Monthly O&M Reporting

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10 References